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GRASS, BRUSH, TIMBER, AND FIRE IN SOUTHERN ARIZONA

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U. S. Forest Service

One of the first things which a forester hears when he begins to travel among the cow-camps of the southern Arizona foothills is the story of how the brush has "taken the country." At first he is inclined to classify this with the legend, prevalent among the old timers of some of the northern states, about the hard winters that occurred years ago. The belief in the encroachment of brush, however, is often remarkably circumstantial. A cow-man will tell about how in the 1880's on a certain mesa he could see his cattle several miles, whereas now on the same mesa he can not even find them in a day's hunt. The legend of brush encroachment must be taken seriously.

Along with it goes an almost universal story about the great number of cattle which the southern Arizona foothills carried in the old days. The old timers say that there is not one cow now where there used to be 10, 20, 30, and so on. This again might be dismissed but for the figures cited as to the brandings of old cattle outfits, of which the location and area of range are readily determinable. This story likewise must be taken seriously.

In some quarters the forester will find a naive belief that the two stories represent cause and effect, that by putting more cattle on the range the old days of prosperity for the range industry might somehow be restored.

The country in which the forester finds these prevalent beliefs consists of rough foothills corresponding in elevation to the woodland type. Above lie the forests of western yellow pine. Below lie the semi-desert ranges characteristic of the southern Arizona plains. The area

we are dealing with is large, comprising the greater part of the Prescott, Tonto, Coronado, and Crook National Forests as well as much range outside the Forests. The brush that has "taken the country" comprises dozens of species, in which various oaks, manzanita, mountain mahogany and ceanothus predominate. Here and there alligator junipers of very large size occur. Along the creek bottoms the brush becomes a hardwood forest.

Five facts are so conspicuous in this foothill region as to immediately arrest the attention of a forester.

(1) Widespread abnormal erosion. This is universal along watercourses with sheet erosion in certain formations, especially granite.

(2) Universal fire scars on all the junipers, oaks, or other trees old enough to bear them.

(3) Old juniper stumps, often levelled to the ground, evidently by fire.

(4) Much juniper reproduction merging to pine reproduction in the upper limits of the type.

(5) Great thrift and size in the junipers or other woodland species which have survived fire.

A closer examination reveals the following additional facts:

First, the reproduction is remarkably even aged. A few ring counts immediately establish the significant fact that none of it is over 40 years old. It is therefore contemporaneous with settlement; this region having been settled and completely stocked with cattle in the 1880's.

Second, the reproduction is encroaching on the parks. These parks, in spite of heavy grazing, still contain some grass. It would appear, therefore, that this reproduction has something to do with grass.

Third, one frequently sees manzanita, young juniper or young pines growing within a foot or two of badly fire-scarred juniper trees. These growths being very susceptible to fire damage, they could obviously not have survived the fires which produced the scars. Ring counts show that these growths are less than 40 years old. One is forced to the conclusion that there have been no widespread fires during the last 40 years.

Fourth, a close examination of the erosion indicates that it, too, dates back about 40 years and is therefore contemporaneous with settlement, removal of grass, and cessation of fires.

These observations coordinate themselves in the following theory of what has happened: Previous to the settlement of the country, fires

started by lightning and Indians kept the brush thin, kept the juniper and other woodland species decimated, and gave the grass the upper hand with respect to possession of the soil. In spite of the periodic fires, this grass prevented erosion. Then came the settlers with their great herds of livestock. These ranges had never been grazed and they grazed them to death, thus removing the grass and automatically checking the possibility of widespread fires. The removal of the grass relieved the brush species of root competition and of fire damage and thereby caused them to spread and "take the country." The removal of grass-root competition and of fire damage brought in the reproduction. In brief, the climax type is and always has been woodland. The thick grass and thin brush of pre-settlement days represented a temporary type. The substitution of grazing for fire brought on a transition of thin grass and thick brush. This transition type is now reverting to the climax type—woodland.

There may be other theories which would coordinate these observable phenomena, but if there are such theories nobody has propounded them, and I have been unable to formulate them.

One of the most interesting checks of the foregoing theory is the behavior of species like manzanita and pinon. These species are notoriously susceptible to fire damage at all ages. Take manzanita: One finds innumerable localities where manzanita thickets are being suppressed and obliterated by pine or juniper reproduction. The particular manzanita characteristic of the region (Arctostaphylos pungens) is propagated by brush fires, seedling (not coppice) reproduction taking the ground whenever a fire has killed the other brush species or reduced them to coppice. It is easy to think back to the days when these manzanita thickets, now being killed, were first established by a fire in what was then grass and brush. Cattle next removed the grass. Pine and juniper then reproduced due to the absence of grass and fire, and are now overtopping the manzanita. Take pinon: It is naturally a component of the climax woodland type but mature pinons are hardly to be found in the region; just a specimen here and there sufficient to perpetuate the species which has evidently been decimated through centuries of fires. Nevertheless today there is a large proportion of pinon in the woodland reproduction which is coming in under some of the Prescott brushfields.

Another interesting check is found in the present movement of type boundaries. Yellow pine is reproducing down hill into the woodland type. Juniper is reproducing down hill into the semi-desert type.

This down-hill movement of type lines is so conspicuous and so universal as to establish beyond a doubt that the virgin condition previous to settlement represented a temporary type due to some kind of damage, and completely refutes the possible assumption that the virgin conditions were climax and the present tendency is away from rather than toward a climax.

A third interesting check is found in the parks. In general there are two alternative hyoptheses for Southwestern parks—the one assuming chemical or physical soil conditions unfavorable to forests and the other assuming the exclusion of forests by damage. When the occasional forest tree found in any park is scrubby, it indicates in general defective soil conditions. When the occasional forest tree shows vigor and thrift, it indicates that the park was established by damage and that the soil is suitable. Nothing could be more conspicuous than the vigor and thrift of the ancient junipers scattered through the parks of the southern Arizona foothills. We may safely assume that these parks were not caused by defective soil conditions. That they were caused by grass fires is evidenced by the survival of grass species in spite of the extra heavy grazing which occurs in them and by the universal fire scars that prevail on the old junipers in them. The fact that they are now reproducing to juniper clinches the argument.

A fourth check bears on the hypothesis that the virgin grass was heavy enough to carry severe fires. The check consists in the occurrence of "islands" where topography has prevented grazing. One will find small benches high on the face of precipitous cliffs which, in spite of poor and dry soil, bear an amazing stand of grasses simply because they have never been grazed. One even finds huge blocks of stone at the base of cliffs where a little soil has gathered on the top of the block and a thrifty stand of grasses survives simply because livestock could not get at it.

The most impressive check of all is the occurrence of junipers evidently killed by a single fire from 50 years to many centuries ago, on areas where there is now neither brush nor grass and where the junipers were so scattered (as evidenced by their remains) that it is absolutely necessary to assume a connecting medium. If the connecting medium had been brush it could hardly have been totally wiped out because neither fire nor grazing exterminates a brushfield. It is necessary to assume that the connecting medium consisted of grass. It is significant that the above described phenomenon occurs mostly on

granitic formations where it is easy to think that a heavy stand of grass might have been exterminated by even moderate grazing due to the loose nature of the soil.

Assuming that all the foregoing theory is correct, let us now consider what it teaches us about erosion. Why has erosion been enormously augmented during the last 40 years? Why has not the encroachment of brush checked the erosion which was induced by the removal of the grass? Why did not the fires of pre-settlement days cause as much erosion as the grazing of post-settlement days?

It is obvious at the start that these questions can not be answered without rejecting some of our traditional theories of erosion. The substance of these traditional theories and the extent to which they must be amended before they can be applied to the Southwest, I have discussed elsewhere.[1] It will be well to repeat, however, that the acceptance of my theory as to the ecology of these brushfields carries with it the acceptance of the fact that at least in this region grass is a much more effective conserver of watersheds than foresters were at first willing to admit, and that grazing is the prime factor in destroying watershed values. In rough topography grazing always means some degree of localized overgrazing, and localized overgrazing means earth-scars. All recent experimentation indicates that earth-scars are the big causative agent of erosion. An excellent example is cited by Bates, who shows that the logging road built to denude Area B at Wagon Wheel Gap has caused more siltage than the denudation itself. Another conspicuous example is on the GOS cattle range in the Gila Forest, where earth-scars due to concentration of cattle along the water-courses have caused an entire trout stream to be buried by detritus, in spite of the fact that conservative range management has preserved the remainder of the watershed in an excellent condition.

Let us now consider the bearing of this theory on Forest administration. We have learned that during the pre-settlement period of no grazing and severe fires, erosion was not abnormally active. We have learned that during the post-settlement period of no fires and severe grazing, erosion became exceedingly active. Has our administrative policy applied these facts?

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[1]A Plea for Recognition of Artificial Works in Forest Erosion Control Policy, Journal of Forestry, March, 1921.

Pioneers and Gullies, Sunset Magazine, May, 1924.

Watershed Handbook, Southwestern District, issued December, 1923.

It has not. Until very recently we have administered the southern Arizona Forests on the assumption that while overgrazing was bad for erosion, fire was worse, and that therefore we must keep the brush hazard grazed down to the extent necessary to prevent serious fires.

In making this assumption we have accepted the traditional theory as to the place of fire and forests in erosion, and rejected the plain story written on the face of Nature. He who runs may read that it was not until fires ceased and grazing began that abnormal erosion occurred. We have likewise rejected the story written in our own fire statistics, which shows that on the Tonto Forest only about 1/3 of 1% of the hazard area burns over each year, and that it would therefore take 300 years for fire to cover the forest once. Even if the more conservative grazing policy which now prevails should largely enhance the present brush hazard by restoring a little grass, neither the potential danger of fire damage nor the potential cost of fire control could compare with the existing watershed damage. Moreover the reduction of the brush hazard by grazing is to a large degree impossible. This brush that has "taken the country" consists of many species, varying greatly in palatability. Heavy grazing of the palatable species would simply result in the unpalatable species closing in, and our hazard would still be there.

There is one point with respect to which both past policy and present policy are correct, and that is the paramount value of watersheds. The old policy simply erred in its diagnoses of how to conserve the watershed. The range industry on the Tonto Forest represents a present capital value of around three millions. Since this is about one third of the total Roosevelt Reservoir drainage we may assume roughly that the range industry affecting the Reservoir is worth nine millions. The Roosevelt Dam and the irrigation works of the Salt River Valley represent a cash expense by the Government of around twelve millions. The agricultural lands dependent upon this irrigation system are worth about fifty millions, not counting dependent industries. Grazing interests worth nine millions, therefore, must be balanced against agricultural interests worth sixty-two millions. To the extent that there is a conflict between the existence of the range industry and the permanence of reclamation, there can be no doubt that the range industry must give way.

In discussing administrative policy, I have tried to make three points clear: First, 15 years of Forest administration were based on

an incorrect interpretation of ecological facts and were, therefore, in part misdirected. Second, this error of interpretation has now been recognized and administrative policy corrected accordingly. Third, while there can be no doubt about the enormous value of European traditions to American forestry, this error illustrates that there can also be no doubt about the great danger of European traditions to Amercian forestry; this error also illustrates that there can be no doubt about the great danger of European traditions uncritically accepted and applied, especially in such complex fields as erosion.

The present situation in the southern Arizona brushfields may be summed up administratively as follows:

(1) There has been great damage to the watershed resources.

(2) There has been great benefit to the timber resources.

(3) There has been great damage to the range resources.

Whether the benefit to timber could have been obtained with lesser damage to watersheds and ranges is an academic question dealing with bygones and need not be discussed. Our present job is to conserve the benefit to timber and minimize the damage to watershed and range in so far as technical skill and good administration can do it. Wholesale exclusion of grazing is neither skill nor administration, and should be used only as a last resort. The problem which faces us constitutes a challenge to our technical competency as foresters—a challenge we have hardly as yet answered, much less actually attempted to meet. We are dealing right now with a fraction of a cycle involving centuries. We can not obstruct or reverse the cycle, but we can bend it; in what degree remains to be shown.

There are some interesting sidelights which enter into the foregoing discussions but which could not there be covered in detail. One of them is the extreme age of the junipers and juniper stumps. In one case I found a 36″ alligator juniper with over half its basal cross-section eaten out by fire. On each edge of this huge scar were four overlapping healings. The last healing on each edge of the scar counted forty rings. Within 24″ of the scar were two yellow pines of 20″ diameter just emerging from the blackjack stage. Each must have been 130 years old. Neither showed any scars, but upon chopping into the side adjacent to the juniper, each was found to contain a buried fire-scald in the fortieth ring. It was perfectly evident that these 130-year pines had grown in the interval between the fires which consumed half the basal cross-section of the juniper, and the subsequent fires which resulted in the latest series of four healings. The

fires which really ate into the juniper would most certainly have killed any pine standing only 24″ distant. The conclusion is that the juniper attained its present diameter more than 130 years ago. The size of the main scar certainly indicates a long series of repetitions of scarring, drying and burning at the base of the juniper. The time necessary to attain a 36″ diameter is in itself a matter of centuries. Consider now that other junipers killed by fire 40 years ago were found to still retain ¼″ twigs, and then try to interpret in terms of centuries the meaning of the innumerable stumps of juniper (the wood is almost immune to decay) which dot the surface of the Arizona foöthills. Who can doubt that we have in these junipers a graphic record of forest history extending back behind and beyond the Christian era? Who can doubt that this article discloses merely the main broad outlines of the story?

The following instance also tells us something about the intervals at which fires occurred. I mentioned a juniper with a big scar and four successive healings of which the last counted forty rings. The last was considerably the thickest. In a general way I would say that the previous fires probably occurred at intervals of approximately a decade. Ten years is plenty of time for a lusty growth of grass to come back and accumulate the fuel for another fire. This would reconcile my general theory with the known fact that fires injure most species of grass, it being entirely thinkable for the grass to recover from any such injury during a ten-year interval.

The foregoing likewise strengthens the supposition that root competition with grass rather than fire, was the salient factor in keeping down the brush during pre-settlement days. Brush species which coppice with as much vigor as those of the Arizona brushfields could stage quite a comeback during a ten-year surcease of fire if they were not inhibited by an additional competitor like grass roots.

Whether grass competition or fire was the principle deterrent of timber reproduction is hard to answer because the two factors were always paired, never isolated. Probably either one would have inhibited extensive reproduction. In northern Arizona there are great areas where removal of grass by grazing has caused spectacular encroachment of juniper on park areas. But here again both grass competition and fire evidently cause the original park, and both were removed before reproduction came in.

It is very interesting to compare what has happened in the woodland type with what has happened in the semi-desert type immediately

below it. Here also old timers testify to a radical encroachment of brush species like mesquite and cat's-claw. They insist, however, that while this semi-desert type originally contained much grass, it never contained enough grass to carry fire. There are no signs of old fires. The encroachment of brush in this type can therefore be ascribed only to the removal of grass competition.

There are many loose masonry walls of Indian origin in the headwaters of drainages both in the woodland and semi-desert types. These have been fondly called "erosion-control works" by some enthusiastic forest officers, but it is perfectly evident that they were built as agricultural terraces, and that their function in erosion control was accidental. It is significant that any number of these terraces now contain heavy brush and even timber. Since they are prehistoric, the Indians could not have had metals, and therefore could not have easily cleared them of timber or brush. Therefore their sites must have been either barren or grassy when the Indians built them. This conforms with the belief that brush has encroached in both the woodland and semi-desert ranges.

In the brush fields of California the drift of administrative policy is toward heavy grazing as a means of reducing fire hazard. If the ecology of these California brushfields is similar to the ecology of the Arizona brushfields, it would appear obvious that either my Arizona theory or the California grazing policy is wrong. The point is that there is no similarity. The rainfall of the California brushfields is nearly twice that of the Arizona brushfields. Its seasonal distribution is different, and from what I can learn there is a great deal more duff and more herbs and other inflammable material under the California brush. It would appear, therefore, that the California tendency toward heavier grazing and the tendency in the Southwestern District toward much lighter grazing are not inconsistent because the two regions are not comparable.

The radical encroachment of brush in southern Arizona has had some interesting effects on game. There is one mountain range on the Tonto where the brush has become so thick as to almost prohibit travel, and where a thrifty stock of black bears have established themselves. The old hunters assure me that there were no black bears in these mountains when the country was first settled. It is likewise a significant fact that the wild turkey has been exterminated throughout most of the Arizona brushfields, whereas it has merely been decimated further north. It seems possible that turkeys require a certain pro-

portion of open space in order to thrive. Plenty of open spaces originally existed, but the recent encroachment of brush has abolished them, and possibly thus made the birds fall an easier prey to predatory animals.

The cumulative abnormal erosion which has occurred coincident with the encroachment of brush and the decimation of grass naturally has its worst effect in the siltage of reservoirs. The data kept by Southwestern reclamation interests on siltage of reservoirs is regrettably inadequate, but it is sufficient to indicate one salient fact, viz., that the greater part of the loosened material is at the present time in transit toward the reservoir, rather than already dumped into it. Blockading this detritus in transit is therefore just as important as desilting the storage sites. The methods of blockading it will obviously be a combination of mechanical and vegetative obstructions, and with these foresters should be particularly qualified to deal. This fact further accentuates the responsibility of the Forest Service, and indicates that the watershed work of the future belongs quite as much to the forester as to the hydrographer and engineer.

EROSION AND FLOODS IN THE YELLOW RIVER WATERSHED

By W. C. Lowdermilk

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The flood problem of the Yellow River and of other streams of North China has attracted the attention of conservationists throughout the world. It is an ever present source of distress to the population affected and of anxiety to statesmen and to those concerned with ameliorating the precarious lot of the populous flood plains. The reduction or prevention of flood damage, therefore, calls incessantly for accomplishment. Studies have been made and methods outlined by prominent engineers for controlling the flood waters of the Yellow River, its tributaries and of the lesser streams of North China. Any specific contribution to the solution has its place. This work of flood control is urgent and waits on constructive action.

North China is afflicted by a succession in rythmic tempo of droughts and floods. The gazetteers of any typical district contain a record of the repetition of flood and drought each of which calamity carries with it distress or famine. Moreover it is a singularly noteworthy fact that the flood damage in North China is incomparably greater and more notorious than in central or southern China. Yet the Yellow River watershed receives, according to estimates based on available precipitation records, less than 20 inches of rainfall per annum. This amount is ½ to ¼ less than the rainfall of central and southern China. The Yangtze River watershed receives an average of over 40 inches but the flood damage is insignificant in comparison. The greatest flood damage does not occur in the region of greatest rainfall but in the region of least rainfall in China. Factors other than the volume of waters are responsible for the flooding.

Unlike other great watersheds of China, that of the Yellow River lies in the famous loess deposits. The loess blanket has not been accurately surveyed but is known to cover hundreds of thousands of square miles. The cover varies in depth from a few inches to over a thousand feet. The average depth may be several hundred feet. The wind blown material comprising the loess deposits is very finely divided. It may be said to be pre-pulverized. In situ it is friable and

possesses a vertical cleavage. When the loess is exposed to the action of running water it melts away into it and rapidly loads the current to its transporting capacity. Only where the surface is protected by a vegetative cover is this tendency to rapid erosion checked.

The floods of North China are intimately related to the erosion of the extensive loess deposits. The building of dikes alone is not sufficient to bring about a lasting solution to the control of floods. Certain elements enter into the situation in North China which should not be overlooked. Something must be done to reduce the wide spread erosion in the loess uplands along with dike construction in the plains of deposition.

As a part of the Permanent Famine Prevention Project undertaken by the University of Nanking the writer is engaged in making investigations of the relationships of forestry to floods and famines and in working out ways whereby tree planting and forest management may contribute to the control of floods and to the industrial and economic improvement of the populations in regions of high famine hazard. One project of these investigations has for its object a study of the run-off conditions of the Yellow River watershed. The writer has recently returned from a two thousand mile trip through Honan, Shensi and Shansi for the purpose of studying watershed cover and erosion conditions. As an outcome of negotiations last year it proved a happy circumstance that a joint survey could be made by O. J. Todd, Engineer representative of the International Famine Relief Commission as an engineer and the writer as a forester. This Mr. Todd was able to do in conjunction with his investigation of the Weipeh irrigation project of Shensi and certain road projects. This trip afforded excellent opportunities to study irrigation, road building, prevention of erosion and afforestation projects jointly.

The portion of the trip wherein observations and studies of run off and erosion conditions were made, extended from the railhead of the Lung Hai Railroad, to Sianfu, two days of which journey were made by boat on the Yellow River to Tungkwan. Tungkwan is the Gibraltar of northern China, and has been important in history. From Sianfu trips were made into the Weipeh district to investigate the proposed irrigation project and into the mountains to the south of Sianfu to investigate forest resources. Finally our route lay in a due northerly direction from Sianfu for over 300 miles where travel was made on foot and by mule through San Yuan, Lo Chwan, Yenanfu and other lesser towns. We left Suiteh on our left and crossed over

the high land to the Yellow River at San Chow. Here the crossing was made into the province of Shensi. We reached the Fenchow-Yellow River Red Cross famine road, 20 li from its western and river terminus. The route lay along this road to Fenchowfu, thence to Taiyanfu and return.

It was along the route through Shensi chiefly that studies and observations of the erosion in the loess deposits were made. Any one who will take the trouble to travel or ride over sufficient of the watershed in the loess country will come to understand one of the primary causes of the extensive flooding in the plains. The vast deposits of loess are traversed throughout by this route. In North Shensi the thickness of the deposits averages perhaps as much as 400 feet, and is like an enormous buff-yellow blanket spread over a pre-eroded landscape. The loess deposit is an impressive phenomenon. Geologically it appears very probable that formerly the loess region was more or less a level plain and rolling hills. But perhaps even more impressive are the evidences of erosion in the loess cover. The rainfall run-off from the region has carved and sculptured the former loess plains into a maze and labyrinth of enormous gullies, up to 600 feet deep. The excavation of its valley by the Yellow River has produced a considerable differential in elevation of plain and river. When the protective vegetative cover, therefore, was removed, the loess material was exposed to active and rapid erosion.

This erosion is not restricted to isolated areas. It affects thousands of square miles. It is an outstanding phenomenon of the region. Numerous times along the route, ocular estimates were made of the percentages of the landscape occupied by steep walled gullies. Fully fifty per cent of North Shensi which could be observed from the trails, is estimated to be occupied by erosion gullies. Sufficient of the loess country was seen to justify the belief that the same or a similar type of gullying must exist over most of the loess country.

In many sections of North Shensi gullying has proceeded so far that the only available location for the trails or mule paths is over the highest peaks and saddles. While this feature inflicted some steep climbing and descents, yet it afforded unparalleled views. The vertical cleavage in the loess material favors the formation of perpendicular and precipitious gully walls. Very frequently one had an indescribable sensation, while astride a pack mule, in passing along the very edge of a gully whose walls dropped sheer downward from almost underfoot, one hundred, two or even three hundred feet to the gully bottom. As the gullies excavate

backward, they force the trails into more circuitous routes. One spends at times, a good portion of the day going around the heads of the immense gully washes. In numerous places where the trail lay along the crest of a divide, gullies had cut backward into the ridge, toward each other, until only a thin wall of loess remained to separate them. The trail of necessity passed over this thin partition wall. Several of these narrow points were measured; one was as narrow as 3 feet. Another was 4½ feet at its narrowest width. In the latter instance, the wall on one side dropped down sheer 100 feet to the talus slope which inclined away to the gully floor. On the other side the wall likewise dropped down an almost sheer 300 feet then inclined away in the talus slope. When one travels for two weeks, averaging 70 li per day, through such evidences of erosion he cannot escape the impression of its magnitude.

It is this erosion which through the agency of the rapid run-off of the heavy summer rains that charges the flood water with unbelievable quantities of silt. The streams come down out of the loess hills as fluid mud. The rapid flow of the upland torrents increases their transporting power to herculean amounts. In accordance with the well known hydraulic law the increase in transporting power is accelerated over fifty times when the current flow is doubled. These torrents come heavily laden, as fluid mud, to the plain, where the profile of the stream flattens out. The speed of the current thereupon is checked and reduced. The transporting power of the flowing water is reduced in a corresponding inverse ratio. Great quantities of silt, are therefore, dumped on the plain to choke up natural and artificial channels. The silt by its quick settling qualities (see John R. Freeman's report, Flood Problems in China) has progressively raised the beds of the streams above the plains. This characteristic has notoriously made the control of floods with dikes expensive and difficult. The silt is responsible for the streams breaking from their barriers. The silt by reason of its fineness is quickly picked up in torrentical flow and is as quickly deposited when the current slows down. The silt burden, accordingly has been primarily, rather than the volume of water, responsible for the flood problems in North China.

From studies of the content of silt in flood waters made by John R. Freeman, Director of the Grand Canal Improvement Investigations, the following striking results are taken. (See Flood Problems in China, by John R. Freeman, page 1148.) The average flood volume for a period of 40 days (1919) was 150,000 second feet. The flood water contained an average of 6.5 percent by weight or 4.5 percent by volume of

silt. The maximum load ran up to 9 and 10 percent by weight. Taking 5 percent as an average by volume the total amount that a single flood brings down is incredible. Freeman hesitates to believe that transport of silt in such quantities has been going on for many centuries. The shore line of the delta, as Freeman points out, has not proceeded seaward rapidly enough to account for such loads of silt.

More study is ostensively needed of this problem but the writer's opinion is in agreement that the movement of silt in the Yellow River flood waters as well as in the usual flow has not gone on at this rate for many centuries. It is his belief, on the other hand, that the erosion has been accelerated and to a dangerous extent in the past few centuries. Some reasons for this will be considered below.

The record of the wanderings of the Yellow River over its delta plain as cited in the Freeman Report from the works of an historian of 200 years ago is in point. The intervals between the major breaks of the river are progressively shorter in time from about 2000 B. C. as the following table derived from the historical record shows.

CHANGES IN COURSES OF THE YELLOW RIVER

No.	Periods in which River held its course in years	Intervals in years
1	2278 B. C.— 602 B. C.	1676
2	602 B. C.— 11 A. D.	613
3	11 A. D.— 893	882
4	893 —1048	155
5	1048 —1194	150
6	1194 —1298	95
7	1298 —1324	35
8	1324 —1852	528
9	1852 —to date	(72)

Certain allowances must be made for minor omissions and for some inaccuracy in the ancient record. Nevertheless if the record is accepted as approximately correct it is apparent that some agency has caused the river to become progressively more restless in its bed. Excavation of the upper channel is not sufficient to account for it. A measure of excavation is had in the ancient irrigation system of the Weipeh, where the canal inlet of the pre-Han dynasty period is left high and dry fully fifty feet by the King River. The excavation of this tributary not far from the Yellow River may be taken as an approximate measure of excavation by the Yellow River itself.

It is to be noted in the table that from 1324—1852 A. D. the river was held in its course for 528 years. This was done by artificial works which checked the natural tendency of breaking away from its ever lifting bed. The fact rather emphasizes this tendency. For it became well nigh impossible to hold the river longer in its elevated course. More study is needed to explain the increasing restlessness of the river, but it is the writer's belief that this is an evidence of the results of accelerated erosion of the loess uplands and further that this erosion has coincided with the expansive denudation by a progressively increasing population. Marco Polo describes in his travel, three days out of Sianfu, great forests filled with wolves, "lions" and wild beasts. This forest is no longer to be seen. As the population expanded from the alluvial plains, which nourished the centers of early Chinese civilization, the forests and vegetative cover was cut or burned from the uplands, step by step until the only forests remaining now are pushed back to almost inaccessible regions of the mountains. The uplands have accordingly been exposed at the same place to the erosive action of the monsoonal summer rains. Other changes very likely came about as a result of this general deforestation, but the result of most concern to the present and future generations is the abnormal and accelerated erosion.

Erosion on the present scale in the loess hill lands jeopardizes the permanence of flood control works. It is impossible to believe that the slower waters of the plains even when confined within dikes can continuously transport to the sea the tremendous burdens of silt brought down out of the hills in the summer torrents. Any large scale flood prevention project must take into account this excessive erosion in the loess hills,—it must provide for reducing the erosion as well as for the training of the rivers.

On this trip through Shensi, the writer studied the possibility of reducing the erosion in the loess hills. The checking of excessive erosion is deemed possible. Furthermore the works of prevention should pay for themselves. Nature has pointed out the way for checking and reducing the excessive erosion. It only requires that the methods indicated by nature be applied, intelligently and on a comprehensive scale.

Nature's method of reducing excessive erosion deserves a short notice. The expression "excessive erosion" is here meant to describe the removal of the soil at such a rate that vegetation is not given time to find lodgement on and clothe the slopes. A certain amount of erosion must take place where excess rainfall runs off into streams thence to the sea. But normal erosion may go on without the destruction of the vege-

tative cover. Where given an opportunity the persistence of vegetative life tends to reclaim the open wounds in the earth's soil cover.

The gully wash is the unit of excessive erosion; it is the means by which the run off waters are charged with the excessive silt burden. A study of the gully therefore is necessary to understand how the erosion proceeds and how it may be checked. The gully in the loess soil is characteristically steep walled by reason of the natural vertical cleavage of the loess deposits. The head of the gully is generally precipitous or boxed resembling a "boxed canyon." The run off is confined between the upright or steep walls. At the base of the walls, however, are the talus slopes, or "toes." The run-off currents first attack and wash away these toe—or talus slopes. Then the current undermines the wall, which parts along the vertical cleavages and drops or caves in, and thereby furnishes a dump of fine material which melts away like sugar in the charging current. The critical point in this process is, therefore, the talus slope; if this can be fixed then the situation is in hand.

In those parts of Shensi where the population is sparse and where the vegetative and tree cover is not constantly removed, it was noted that the talus slopes were covered by herbs, shrubs and trees. The raw soil was not exposed, and run-off waters could not be overcharged with silt. The remedy, therefore, is simple and lies in fixing the talus slopes of the gully washes. The talus slope is the key to the situation.

That the talus slope may be fixed artificially is proved by the fact that it is done in a few cases in North Shensi by the planting of willows. It is very unlikely that the farmers planted the willows to stop erosion, but rather to produce wood material. But the production of needful wood material in these instances had the further beneficent result of stopping excessive erosion. The method which should be put into practice is stated as follows: Plant trees of several species in the bottoms of the gullies and on the talus slopes. Willows and poplars, should be used very extensively. Also such species as the black locust and the native catalpa, both of which have the faculty of extensively reproducing themselves naturally by root suckers are especially advocated. It is not enough to plant a row of trees but to plant sufficient to produce a dense stand. The slogan should be: Fill the gullies with trees rather than plant the hills with trees.

Other advantages of this remedial measure exist. North China is afflicted with a long dry winter and spring which makes the starting of trees on the uplands very difficult or impossible if they are not watered for two or three years—an expensive proposition. But the bottoms

of the gullies are near the water table and are generally moist. Trees are easily and cheaply started in them. Furthermore the growth of the trees in the gullies is much more rapid than on the tops of the hills. Wood is produced more rapidly per unit acre, and the more level portions of the uplands are sown to wheat, which is managed as a dry-farming crop. Forests in this case should not supplant wheat fields. The gullies are not only a hazard but are waste land areas and comprise fully fifty percent of the land surface. The planting of the gullies with trees fortunately may become both self-supporting and a beneficent erosion control measure.

Every effort is needed to push forward this type of afforestation in the loess lands. Each provincial famine committee of the loess provinces would do well to include this type of erosion prevention as a famine work project along with the irrigation and road work projects. There need not be a conflict, for the afforestation projects would call principally on the labor supply of the more rural sections. Villages should be held responsible for checking erosion within their precincts by planting up the gullies therein. These gully forests or plantations should ipso facto become village, communal or municipal forests, administered, guarded and managed by the villages according to simple rules in forest management for the benefit and profit of the village or municipality concerned. The sale value of wood material in the loess region indicates that a considerable revenue would accrue to the villages.

The reduction of erosion, or the prevention of excessive erosion in the loess uplands is an important part of the flood control measure for the plains. It must not be overlooked. Filling the erosion gullies with trees rather than covering the hills with trees is the solution, and likewise should become when efficiently carried out a self-supporting enterprise.

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ANGULAR SUBMERGED TREE PLANTING

By J. R. Simmons,

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Those who read the paper by C. G. Bates on erosion in the May number of this Journal will recall the very excellent summary at the end, setting forth "the methods by which erosion on the National Forests may be checked, and damage........prevented in the valleys of the larger streams." Mr. Bates gave as the 11th step in prevention the following: "Stop by dams, by fencing against stock, *by willow planting,* or by filling with brush, the erosion of gullies already started." It is my desire to contribute something on that particular phase of erosion prevention which is suggested by the use of *willow,* and the facts presented will refer to a new system known as angular submerged tree planting.

The Forestry Association in New York State was called upon in 1923 to save from erosion a Boy Scout camp located a few miles from Albany, N. Y., on Kinderhook Lake. This camp was a gift to the Fort Orange Council of Scouts and is estimated to be worth $50,000.

Eight years ago, the land sloped gradually to the water's edge and was in part covered with a heavy growth of mature hardwoods. There is a dam at the foot of the lake, and owing to the particular privileges enjoyed by the owner, the water level of the lake was alternately raised and lowered to the extent, at times, of nearly ten feet. This was responsible for the initial undermining of the banks, and was followed in a short time by disastrous consequences from rain, melting snow and the action of frost. There are now precipitous banks on the property ranging from five to twenty-five feet, and three quarters of a mile of shore line is subject to heavy erosion. The property has receded more than fifteen feet in eight years.

Construction of a retaining wall of concrete was suggested but was found to involve too great expense and to threaten the natural beauty of the camp. Hundreds of small trees had been planted on the banks, but these, together with oak and pine upwards of two feet in diameter gradually found their way into the waters of the lake.

The system which eventually solved the problem was originated by O. S. Scheifele, a Canadian, following several years of experimentation

on a river bottom farm in Ontario with logs of white willow (Salix alba). Scheifele succeeded in patenting his idea both in the United States and Canada, and the writer has never described "angular submerged tree planting" without being asked to explain how it was possible for a man to obtain a patent on the "right to grow a tree." It was, of course, the unique method used in laying the poles into the soil, fastening the cross sections and tapping the moisture from below the water level that gained for the originator his patent. There would be no infringement, so far as I know, on the part of any man who decided to cut willow logs and lay them along an eroded bank, or drive them into the soil above or below the water line. Having followed Scheifele through several jobs, involving lake shore erosion, railroad landslides, etc., I feel reasonably sure that his exact idea is in no danger of being infringed upon for some little time. Mr. Scheifele, by the way, is not a forester, but his idea may become of practical interest to foresters in the engineering field, and especially to railroad men within the next few years.

We shipped a car load of willow logs to the camp last April and tackled the job as soon as the frost was out of the ground and the lake at high water mark. The logs, or poles, averaged from 2½ inches to 6 inches in diameter, and from 12 feet to 25 feet in length. These poles provided for a strip of shore line three quarters of a mile long. The main points concerning installation of the system are as follows, and I omit further detail in connection with the rights of patent.

The poles were laid in shallow trenches along the slope of the bank, from a point about two feet below the water line to the top of the bank, and spaced about five feet apart. Their appearance when so laid is not unlike the rafters of a house,—the eaves representing the water level, and the ridge pole the top of the bank. At Camp Hawley the angle of slope was between 20° and 45°. The trenches were continued inland at the top of the bank so as to provide for clinching the end of the log. All fastenings, such as posts, cross sections, etc., were of willow.

The Scheifele system provides for a low retaining wall of boards or planks or sand bags at the water's edge to prevent wave action during the first year from forming a "straight edge" against the vital point, i. e., the point at which the whole fabric gets its water supply. At Camp Hawley this buffer wall was built of willow logs held by posts of the same material.

In describing the results of the work I can merely state what has

transpired during a growing season of two months, or to be more exact, sixty-four days.

Practically every log has sprouted from end to end, the growth averaging 24 inches. Investigation of the root systems indicates a penetration of from one to two feet into the soil. No new gullies have formed at any point along the bank, and the whole appearance of the eroded area has changed from that of bare gravel and sand to that of a living wall of willow.

One interesting feature connected with this work was the sprouting and rooting of the willow posts used in the sides and top of the eroded banks for the purpose of holding the logs in position. Observing that many of the posts carried sprouts 10 to 12 inches in length, the writer investigated the use of willow on blow sand areas and found that much had been accomplished along this line, especially on the Canadian prairies. In many cases, willow logs laid on the ground in extremely sandy areas, and covered with a light layer of earth, have survived and aided materially in reclaiming the area. There are, of course, many uses for willow lumber, and the Salix alba is capable of development into a tree of considerable size.

CORPORATE VERSUS PUBLIC OWNERSHIP OF LAND FOR FOREST PRODUCTION AS APPLIED TO THE STATE OF CONNECTICUT

By H. H. Chapman

By forest production we mean the business of growing crops of trees to be cut and sold. The primary purpose of this business is public benefit. The discussion of ways and means is based on the premise that wood is in demand and must be grown as a public necessity. The question under consideration is the best means of attaining this end. As in similar cases, the choice lies between private initiative, whose driving force is profit, and public management, whose goal is service. The methods must be chosen purely on the basis of the best attainable results. The choice must be guided by experience, where this is available, supplemented by comparison or analogy with similar enterprises and, to a certain extent, must rest on reasoning or deductions as to probable results, whose correctness can be proved only by the actual test of time.

Some enterprises have come to be managed wholly by the public, such as roads and the postal service. Others are largely public, as is education. In most instances private enterprise preceded and still supplements all forms of public service. In the fields of merchandising, manufacturing, mining, agriculture, and transportation, private initiative is paramount, but is supplemented by public education, research, regulation and cooperation. In considering a specific question of public welfare it gets us nowhere to insist that private initiative is the sole possible means and apply the epithet of socialism to public business without examining the facts and premises. Nor is it safe to trust to public activities alone to put through an economic program and neglect the possibilities which lie in private industry.

In the United States and sixteen of our forested states, the policies best calculated to bring about the establishment of forestry as a successful business have already been under active trial and experiment for a period of about two decades, in some instances longer. These indicate that forestry calls for the public ownership on the one hand, and a continuation of private ownership on the other. Neither policy should or can be adopted to the exclusion of the other. A variable, but large per cent of the total forest area should be acquired outright by the public and operated as productive forest estates, the remainder con-

stituting private forests of many different kinds and character. Not only have these sixteen states, and the national government come to this conclusion, but the older nations of the world based on a wealth of experience covering several centuries, have reached the same conclusions, and where the balance has swung too far away from state ownership, these nations have corrected and are still engaged in correcting this balance, by outright purchase of lands. This is the case in Sweden, Germany, and Italy today, or was before the war impoverished the finances of the two latter contries.

Private ownership of forests continues on a large scale in all these countries for many reasons, historical, economic and social, just as it will continue with us, and should. As a practical measure for increasing wood production, it is easily possible to compare the known and proved results of these two policies, where they have had time to operate.

It is generally conceded in Europe that public forests are better managed, and produce much greater quantities of wood of superior quality and higher value per acre than private forests. These latter forests are always cut at an earlier age. On private forests the products are of lower grade and bring less on the market, the yield per acre is smaller and the forest is less ably managed, is not so frequently thinned, there are more inferior trees and species, more damage occurs from fire and insects and generally poorer results are obtained than on those publicly owned and operated. But these private forests, when cut at these short intervals, may yield a higher profit to the owner than to the public forests. This result is due to the fact that the measure of profit which is applied to private forestry is the rate of compound interest earned on the investment. When income is deferred over long periods, business custom has so far insisted that the rate of earnings be computed at compound interest.

But compound interest is a geometric progression, and any geometric progression extended even for a comparatively short period of time soon comes into collision with the opposing law of limitation of space and of opportunity for expansion, which, in business, is termed the law of diminishing returns. The growth of population conforms to this law, and so does the growth of any business, or of a crop of forest trees. In fact, by merely insisting on the necessity of six per cent returns and then demanding the uninterrupted accumulation of income on the basis of compound interest at this rate, it is possible to prove mathematically that every state forest in Europe is bankrupt and

that no private owner can ever attempt to grow trees for profit except under the most favorable circumstances.

The secret of successful forestry as a business lies, not in earning a high rate of compound interest, but in the possibility of establishing the forest as a going concern actually producing an annual income in excess of all expenditures. When this idea is grasped and achieved in management, compound interest ceases to trouble the owner whether it be the state or the private capitalist. The goal then becomes the production of the greatest net annual income or surplus over expenses. This requires the building up of the forest capital to sizes and ages which yield the higher classes of products which have the greatest economic or public value as indicated by prices.

But private investors fail to attain this goal for two outstanding reasons. In the first place, they are poorly equipped to endure the initial, long period of establishment corresponding to the growth of the crop of trees and they are constantly tempted, not only to cut too soon, but to cut too heavily. There is nothing to stop them from this over-cutting or withdrawal of forest capital. But the public suffers in that the better grades of wood products are not then produced in sufficient quantities to supply industry. These laws have operated powerfully in Connecticut, leading to the clear cutting of sprout forests at ages as low as 20 years, merely for cordwood, and reducing, materially, the yields of lumber and crossties, poles, and piling besides causing the forest to deteriorate with every successive cutting until, with the advent of the chestnut blight, the finishing blow was dealt to many woodland tracts.

From time to time, and in various states, the proposal has been made that the need for stimulating forest production can best be met by utilizing the modern business structure of the corporation, thus combining the interests of a large number of smaller owners of woodlands, securing all the advantages of large ownership, and doing away with the necessity of state ownership and management. We should examine this proposal fairly.

Large ownership is not only an immense advantage but almost a necessity in forestry, unless the tract is a mere adjunct to a farm or estate which carries most of the overhead. The requisites of financial success in commercial forestry are low initial costs, low annual cost of protection from fire and expert technical guidance or management whose overhead cost per acre is low. This reduction in unit costs may only be achieved by spreading them over an area large enough to

absorb them efficiently. In the harvesting and marketing of the crop, the two chief objectives are a sufficiently large supply to command a stable market, and the ability to distribute the cut or perpetuate it and thus attain the status of a going concern. Both these objectives call for large areas. These advantages are gained by mere size and compactness of area, independent of the character of ownership, hence the above arguments are just as valid for state as for corporate ownership.

Owners of small tracts suffer disadvantages in fire protection. These may be overcome by the device of forming protective associations employing a common patrol, or establishing towers, leaving each owner to put on any additional improvements needed such as fire lines.

The advantages of technical assistance are secured in part by cooperative activities of the state, through advice and examinations and advice in the management of small forest areas. The biggest handicap is in marketing the crop. Except for cordwood, and ties the owner frequently is unable to get a fair price for his products, and might be benefited by a cooperative marketing organization. The corporations at present operating and owning woodland in Maine and elsewhere have not in any known instance been organized solely to acquire deforested land and grow timber as a commercial crop, for their sole objective. Instead, they are engaged in some form of industry which utilizes the wood crop and have acquired these lands for the timber already upon them needed as raw material in the industry. There are some instances where these lands have been retained and managed with the purpose of continuing the production of wood in an effort to maintain or prolong the supply of these needed raw materials. This system can be made successful if the forest is taken in time, its wood capital not too far depleted, and a policy of cutting inaugurated which maintains the forest as a going concern, by not removing more than can be grown to replace it. But these instances are rare, and in Connecticut are confined to the production of cordwood to supply certain industries, some of which are even now substituting other fuels.

The test case is a corporation formed not to manufacture something, but solely to grow timber. Such a concern can acquire but limited and scattered areas containing timber already of merchantable size. It can find considerable tracts of immature sprout hardwoods, and of abandoned fields not yet reproduced to any valuable species. It must inevitably undergo a more or less protracted period of waiting and of constant outlay, before it becomes a going concern earning a

surplus and paying annual dividends. Faced with this condition, there are two obstacles to successful management. First, capital stock must be the basis of any such corporation, and stockholders will usually expect either annual dividends or a guarantee of compound interest on deferred dividends. Annual dividends can be paid only by borrowing or out of increased capitalization. The stockholders will expect six per cent and it will be practically impossible to satisfy them if a sufficiently low rate is paid to be safe for a period of 40 to 50 years, considering the law of geometric increase of compound interest. If the property is bonded, the interest on the bonds presents similar difficulties. These obstacles are inherent in any proposition requiring deferred returns. In the second place, the corporation must be the absolute owner of its lands, free to manage them as it sees fit, or to buy, sell, or exchange them, otherwise it is not a true business organization but merely a cooperative association. If the landed property of such a corporation is composed of the woodlands of a large number of owners, adjunct to their farms or estates, or regarded by them as having any of the attributes of personal possession, these owners will not, under any conceivable circumstances, permit the corporation a free hand in cutting and selling their timber and will, in fact, endeavor to dictate every item of management with the result that either they will wreck the enterprise, or else being unable to have their own way, will withdraw or endeavor to do so. The sense of pride in individual ownership of forest land is too strong to permit of anything more binding than a voluntary association for fire protection, technical advice and cooperative marketing in which each owner's initiative and control of his property is protected. These two rocks will, I am certain, wreck any attempt at corporate ownership of forests which must face a period of continuous outlay without dividends. Such a condition also puts a big strain on corporate management, as witness the failure of several real estate companies in New York (the American Real Estate Company and others) which attempted to float 6 per cent bonds for a 20 year period of deferred compound interest, resulting in the bondholders losing both principal and interest.

This being the case, it is probably a very poor policy to attempt to bolster up such a corporation by various provisions for State aid or encouragement. With or without these aids, it is bound to fail and the effect of such failure is certain to bring into disrepute the measures by which it was hoped to artificially stimulate its success. The measures suggested are, full tax exemption of property belonging to

such a corporation, a state cash subsidy as a revolving fund to get it on its feet, and the compulsory requisition of state officials as for instance, the state forester, to act as business manager in certain important particulars such as appraising the value of wood lands as a basis of exchange for stock, and the directing of all marking of timber for sale.

The total exemption or even the partial exemption of property from taxation as a means of encouraging infant industries is resorted to sometimes by communities which expect to benefit by the increased industry, population and other values thus created. But these benefits, in the case of manufacturing industries, are immediate and evident, while with forest tax exemptions the loss of taxes is the only immediate result observed by the public. Some day, the next generation will receive the benefit. Such a measure on such a basis has never yet received the practically unanimous public support needed for its adoption. Even the state forests in Connecticut pay the local taxes so that there is no loss of revenue to the towns. The kind of forest tax reform needed is not a special subsidy to a private corporation, but a general change in the present system in all woodlands alike, whereby the land alone pays an annual tax and the values added by the young and growing timber are not taxed until they mature, and then preferably by a yield tax at the time of cutting. The adoption of a plan of tax exemption instead would block adequate tax reform and bring it into disrepute. In the same way a large subsidy or revolving fund intended to finance such a corporate experiment would tend to block appropriations for the purchase of state forests. Again, if the state forester were required to act as arbiter in assessing the value of woodland property, as a basis for stock, he is diverted from a public to a private function, and in the almost inevitable smash up which would follow the failure of the company to pay dividends for many years, and the pulling and hauling of individuals who still regarded their woodlands as belonging to them rather than the company, the state forester would bear the brunt of all complaints and be thoroughly discredited.

We thus face a proposal which must encounter conditions radically different from those with which ordinary business corporations must deal. It is not impossible for a corporation to succeed in such a venture, but it is most improbable. Even the normal shifting of ownership by deaths, sales of stock or other causes would precipitate trouble during the long formative period since, in the absence of income, the values of the stock would be problematical.

Instead of lending various forms of state aid to such a venture, which would confuse the minds of the public and prejudice sound policy and progress in taxation, public ownership, and efficiency of public organization, the alternative of state ownership should be examined.

We have seen that all the advantages of large holdings as to economy of operation, sustained output and establishment of markets is applicable to state holdings.

In the second place lands once acquired by the state for forestry are in permanent stable ownership. The public is not apt to wish to relinquish or sell them. This means that a continuous stable policy of forest management necessary to produce crops requiring 50 years or more, can be actually carried out.

Third, if it is considered necessary to reckon the probable returns on the basis of compound interest, the state commands and can base its demanded return on a considerably lower rate than a corporate owner.

In the fourth place, as the specific objective of timber production is direct economic benefit or service to the public by providing wood supplies, the logical plan is to use those means which are most directly calculated to give the maximum of service rather than the maximum of profit. The two are by no means synonymous in the production of timber. The largest ultimate net cash profits per acre will not be obtained by private forestry because the desire for compound interest returns induces an earlier cut and interferes with economic benefits and economic laws.

Fifth, as the result of this conflict, the large timber from which the more valuable products of the virgin forest have been obtained must be grown in the future on public forests or it will not be grown at all, and no one will pretend that such products are not needed.

Sixth, it is a fact not well recognized, that the more timber is grown in the future in a region the better the prices will be for this timber. This is due to reduced costs of production, of harvesting, and marketing, the preservation of wood using industries, which make highest use of the product, and the elimination of freight charges on long hauls to distant markets. Hence a large nucleus of well managed public forests insures better profits for all private forests in the vicinity.

Seventh, the state is in no sense entering a private field in detrimental competition with private industry. The business of growing the timber on publicly owned lands can, as shown, be practiced with

decided advantage, both to the public, and to private "competitors." The business of logging and of manufacturing the timber can be and is customarily left in private hands, by sales of timber on the stump, and public forestry thus not only encourages private enterprise in lumbering and utilization, but is the very basis of it.

Eighth, the character of the operations in forestry is such that with a trained forest personnel, these operations can be and are conducted by public departments efficiently and economically. The ability of the state because of its normally large operation, to employ men with technical skill and administrative experience offsets any possible loss of efficiency commonly supposed to inhere in public works. The work of forestry consists, primarily, of guiding natural processes by preventing damage, securing natural reproduction, selecting and marking trees for thinning and final harvest, and conducting or supervising all operations in such ways, and with such knowledge of natural laws that these great living forces of the forest are brought under complete and beneficial control. Time, rain and sunshine do the rest. The very impatience for results inherent in private enterprise defeats its own ends, causes private investors to spend too much money on hurry up processes, and renders private forestry *less,* not *more* efficient than public management, and the proof may be found wherever the two systems have operated side by side in any country.

But there remains a further reason for public forests, and that is the constantly growing need of the public for open areas for recreation, and for the preservation and breeding of game. Parks alone will not suffice, for parks in Connecticut mean seashore, waterfalls and mature woodlands and because of their exceptional values are necessarily restricted in area, and pay no taxes. The state forests, upon which timber may be cut and which pay taxes, offer the means of expansion into large tracts open for camping, hiking, and all forms of free outdoor sport, and large enough to form real nuclei for the propagation and protection of our vanishing game birds and animals.

These public benefits are a compensation for the expenditure of public funds for purchase and management of state forests during the period required to bring them to a state of revenue production. Unlike other state expenditure such as roads, or education, public forests will ultimately not only produce the economic benefits for which they were established, but will yield a net cash income to the public greatly in excess of all current expenses. The net income in the established forests of continental Europe varies from 40 to nearly 70 per cent of

the gross revenue. There is no deterioration of the investment in forest land on which a growing forest is established. Roads and other public works require constant repair and final renewal. Forests, properly managed, renew themselves.

The policy of the Connecticut State Park and Forest Commission, and of the Connecticut Forestry Association is to advocate the purchase of 200,000 acres of forest land for state forests. This is about one-eighth of the forested area of the state and less than one-tenth of its total forest and unimproved land. The increasing recognition by business interests of the need of such a policy was strikingly shown by the recent action of the National Chamber of Commerce which, on October 3, 1923, adopted by referendum of its members the following recommendations:

I. The Committee recommends that the Federal Government should, for the protection of headwaters of navigable streams and to the extent permitted by existing law, acquire, reseed, and replant waste lands on which the reproduction of forest growth can not be obtained by natural means, with discretion in the Secretary of Agriculture to prefer lands in states which provide at least an equal amount of funds for acquisition of such lands.

II. The Committee recommends that states and municipalities should acquire, reseed, and replant the remainder of such waste lands.

The chief criticism of these recommendations is that by inference they limit the policy of the state to the acquisition of denuded lands only, which is just as poor policy for the public as it would be for private corporations.

The policy of establishing as rapidly as possible a large body of publicly owned forest land, which neither precludes nor interferes with private enterprise in forestry, represents the best and most satisfactory method of achieving substantial progress towards restoring the forest wealth of Connecticut and eventually making her self-supporting and independent of all outside sources for the wood and lumber needed by her home industries.

DISCONTINUOUS GROWTH RINGS IN CALIFORNIA REDWOOD

By Emanuel Fritz and James L. Averill,

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Examples of eccentric ring growth are found in both gymnosperms and angiosperms, in the branches as well as in the stems. The common form of eccentricity or asymmetry is that in which the annual rings are wide on one side and narrow on the opposite, very common indeed in branches where radial growth is greatest on the lowest side and least on the upper side. But there is another form, not so commonly found and often escaping attention, in which, during part of the tree's life the rings are not continuous, that is, they are prominent on one side of the stem and entirely lacking on the opposite. While the senior author was conducting a stem analysis of some second growth redwood a number of examples of asymmetry due to such discontinous rings were met with, and these proved to be so disturbing in the determination of age as to warrant special study. This paper embodies the results of a microscopic examination of sections exhibiting this phenomenon and a study of the probable causes.

The stem analysis above mentioned was an incidental feature in cutting a three quarter acre plot containing about 60,000 board feet of second growth redwood to determine the quality of the wood. The area lies on Big River, Mendocino County, California. Following logging 65 years ago, second growth rapidly took possession and developed into an excellent young forest. All but one of the coniferous second growth trees were of redwood (Sequoia sempervirens) and they ranged in diameter from 3 inches in a few cases to 39 inches, breast high, and up to 150 feet high. Early in the stem analysis work difficulty was encountered in determining ages at several cross sections. Ring counts made on several radii on the same and different sections of the same log gave contradictory ages. It soon became obvious that the average radius did not always contain one ring for each year of growth. One tree was finally found where the anomaly was so marked that even a field examination left no doubt that this was not a case of "false rings" but of true rings that did not reach entirely around the tree. This particular tree, at the section shown in Figure I, gave a count of as many as 51

rings on one radius, and only 35 rings (32 for a short distance) on a radius 45° to one side. This divergence was found to exist the entire length of the merchantable stem and always on the same side of the tree. Including the tree above mentioned there were about 15 trees that gave trouble in determining ages, but on only five of them was detailed data

Figure 1.—Section showing discontinuous growth rings. The rings between A and B cease to exist in the region indicated by C. Section cut 33 feet above stump.

recorded concerning discontinuous rings. According to the position of their crowns in the forest canopy all the trees were classified as either dominant, codominant, intermediate, or suppressed. Of the five trees specially recorded as having discontinuous rings, only one was in the dominant crown class and unfortunately no observations were made to determine if this tree had been in the dominant class when the eccentricity began. One intermediate and three suppressed trees completed the

group. Each of these five trees had an abnormal top, being either forked, broken, or exhibiting a sudden constriction in diameter. The latter was the case of the one intermediate tree, and it normally would have fallen into the suppressed class but for the side light it was receiving from a railroad right-of-way. This tree, number 90 of the series, is the one mentioned above and supplied the material for this study. It was 18 inches in diameter, breast high, and 80 feet high in round numbers. Figure 1 is a cross section of this tree made 33 feet above the ground. The development of growth rings was normal until the year A, and from year A to year B, about nineteen years, rings developed principally on only one side. After year B the rings can again be traced around

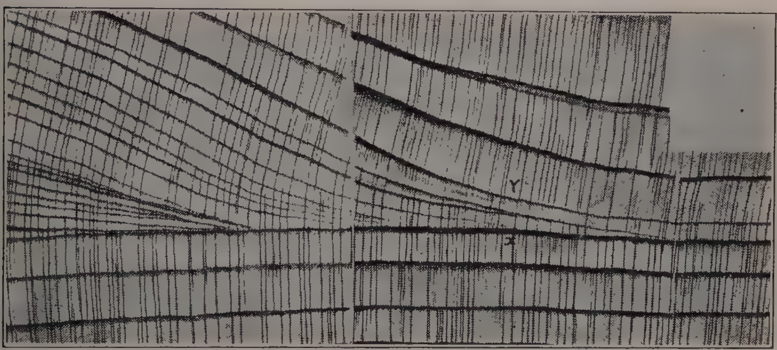

Figure 2.—Photomicrograph of region around C in figure 1. The rings do not "merge" but cease to exist.

the entire stem. At C the discontinuous rings seem to merge or fuse, and one is apt to suppose that all the nineteen rings between A and B continue beyond point C as a thin single ring or a group of extremely fine rings. That this is not the case is clear from Figure 2, which is an enlargement of the region about C. Each ring as it approaches C becomes gradually narrower, at first through a diminution of the number of spring wood cells, counted radially, then of the late wood cells, until finally there is not the slightest evidence of cell formation except that the first three of the nineteen years are marked by portions of rings in the dormant area. The cambium beyond the point C was obviously dormant for practically nineteen years, and completely so for 16 years. One might expect that in this dormant section each ring would have been represented by at least a desultory formation of a few late-wood cells, but such is not the case. Circumferentially, the rings cease to exist for about

150 degrees, and the "pick-up" of the lost rings thereafter in this example is very irregular and not so easily studied as at C. Another noteworthy feature is the change in the direction taken by the medullary rays with each new ring. This might be expected however as the rays tend to maintain a perpendicularity to the rings.

The cells in the outer edge of each discontinuous ring are narrowed radially, in some cases so much so that the lumen is barely perceptible. In other cases the tangential walls as seen in cross section are curved, the outer walls being concave, suggesting a development under considerable pressure in a peripheral direction. This anomaly does not seem to be explained by any of the better known ring growth theories. Sach's bark pressure theory might seemingly be quite probable as to the cause of the compressed late-wood cells and uncompressed early-wood cells, but it is improbable that the pressure of the bark could change so materially within the space of one cell width. Instead of an even row of late-wood cells with a clean well-defined line representing the limit of the year's increment as found in normal growth, there are found occasionally some large thin-walled cells, giving to the outer edge of the late-wood of each partial ring a saw-tooth appearance.

Redwood is a singular tree. It is subject to many forms of anomalous growth. Burls, for example, are not uncommon and reach great size; often there is a narrow bracket or flange, occasionally over 2 feet long, between the lower side of a branch and the stem, forming an important mechanical support for far-reaching branches; occasionally we find pendulous growths resembling burls and called "hanging knecks"; seedlings often develop a bulb-like burl just below the ground line, the "burl" sprouts readily and is an important agent in reproduction should a fire kill back the treelets. Most important of redwood's singular habits is its prolific and persistent sprouting from the roots, stump base and stump top, logs, or burned trunks. Albino sprouts are not uncommon. Important also is the tree's remarkable ability to withstand dense shade for several hundred years, and then, if the overtopping trees are removed, to continue life with greatly accelerated growth in diameter and height. Few tree species possess such remarkable vitality and this valuable trait in redwood, as will be pointed out, no doubt accounts in part for its formation of discontinuous growth rings.

An explanation of the probable causes underlying the formation of discontinuous growth rings in second growth redwood must be preceded by a description of redwood sprout clumps. Immediately after logging, sprouts in large numbers appear around the stump but only a few suc-

ceed in the struggle for ascendancy. After 50 years there may remain only five or six sprouts, now each 20 inches or more in diameter and over 100 feet high, with one or two of them dominating the others. They form a circle around the mother stump. Should a person stand in the center of the circle and look up, he would see an opening almost clear of living branches except at the very top. Nearly all the green branches are on the outside of the clump. Individual trees in a clump are quite one-sided, with green branches 20 ft. or more long on the side away from the center of the clump, and, except at the top, absent on the opposite or inner side. Should a tree lose about 20 ft. of its top as suggested below, there will be no green branches at all on that side of the trunk nearest the center of the group. Furthermore the tree will be deprived of top and side light. Most of the examples of discontinuous rings were found in trees of the lower crown classes and undoubtedly these trees fell into these classes because of loss of their tops earlier in life, as indicated by the trunk deformities and because previous to the sudden change to discontinuous ring development the cross section manifests rapid and uniform diameter growth. Young redwood trees often suffer a serious injury to their tops or their complete loss due to the work of rodents, either rats or squirrels, as there are no porcupines in the region. One observer has actually watched the large gray squirrel of the region strip off the bark where the stem was about 4″ in diameter. The animal seems to relish the juicy layer just under the bark. Sometimes the girdling is complete in which case the top dies and is later broken off by the winds. If a narrow strip of bark is left the great vitality of the species permits a rapid healing of the wound, but a weak spot remains and a strong wind might easily snap off the top. On this sample plot there was much of such damage. Most tree species thus deprived of their tops would soon be shaded out, redwood however will persist and make a valiant attempt to recover its place in the crown canopy, though not often with success, for the unbroken neighbors rapidly take advantage of the opening and soon fill it with their own crowns. The broken-topped tree is thus left a subordinate but obstinate member of the stand, with branches on only one side and denied all but a little light. Small wonder then that its food making machinery is crippled. Photosynthesis becomes confined to the branchy side of the tree, encourages radial growth on that side even more than before the top was lost, and continues thus until a new top, with foliage all around it, is formed. The side lacking branches has no opportunity for photosynthesis, and, in the case studied, made no radial growth.

This bears out the theory of Mer,[1] that radial growth begins where most food is stored and is most active and persists the longest in such regions. Wieler[2] concluded from experiments that shortage of metabolized food induces the formation of summer-wood thereby producing the annual ring demarcation. If the branches are removed from one side, the amount of metabolized food will be decreased, especially on the side with the least number of limbs and only summer-wood cells will form. In the extreme case, so little metabolized food might be available that portions of the cambium would remain dormant for a period of years, forming no cells whatever, while on the opposite side, regular growth would occur. The fact that suppressed trees are subject to anomalous ring growth was observed by De Bary,[3] who states: "In cases of eccentric ring formation, indistinctness of the limits between the annual rings often takes place in such a way that two distinct rings on the stronger side run together into a single one on the weaker. Total or partial suppression of the growth in thickness during a period of vegetation has been demonstrated in stunted trees by R. Hartig." If it were possible for the tree to distribute food materials peripherally, growth rings should be continuous. That such distribution can not take place very far peripherally, particularly in trees of the subordinate crown classes, seems to be emphatically demonstrated in the entire absence of cell formation in the region between C and D in Figure I, the region of no green branches.

Aside from the observations noted above, an additional object of interest is afforded by the cross section of tree No. 90 in Figure I. After continuing for 19 years to form rings on only one side there was a sudden resumption of the formation of complete rings, continuing until the time the tree was cut. This is explained thus: About twelve years before cutting, a railroad right-of-way was cut through the stand leaving this tree on the edge of the clearing and allowing it considerable side light. Thus stimulated, new and vigorous branches were put out toward the opening, increasing the foliage area for photosynthesis. Until this time the tree must have been in the suppressed class, then the added light raised it to the intermediate class; the new branches had practically full light, and soon developed into a more active food making laboratory than the older and stunted branches. They also extended far into the side, corresponding to C-D in Figure I. The sudden recovery of normal ring development following a better distribution of branches, as well as the formation of wide rings on the side once dormant, lends great strength to the theory referred to

in the preceding paragraph, and that therefore, complete or continuous ring development in the case of young redwood, is contingent on green branches being disposed entirely or nearly entirely around the stem.

Influence of gravity and compression have been suggested as the cause of eccentricity which appears in the branches, while bark pressure, food distribution, compression, exposure and wind action are a few of the theories already advanced to explain eccentricity in the stem. When a plant grows in a leaning position, the lower side grows under compression and the upper side under tension due to the pull of gravity. It has been proven by experiment that the portion under compression grows faster, radially, than it would normally. The compressive force seemingly stimulates the cambium, causing it to divide more rapidly than otherwise. Compression as a cause of eccentric growth is doubtful in this case, because the stems grow in a practically vertical position. The side of the stem containing all the branches might well be considered under compression, due to their weight. Wood formed under compression is very characteristic; all the cells are thick walled; the small lumen are distinctly rounded and intercellular spaces are minute. As a result, compression wood is dense and comparatively hard. None of these features were found in the sections under study.

The matter of ring fusion has very little economic importance because the lower crown classes produce only a small amount of the lumber cut on an area and the quality of the lumber is not effected except as to fineness of grain. It is however an important matter to the forester who depends on the increment borer for determining the ages of standing trees.

Summary and Conclusions:

1. Discontinuous growth rings are prevalent in second growth redwood. For long periods of years rings may be produced on one side while the other remains dormant.
2. Discontinuous rings introduce an important source of error in determining ages of standing trees with the increment borer. If trees of the subordinate crown classes must be used because others may be too large, the borer should be introduced from the side containing most of the branches.
3. Redwood trees arising from sprouts and growing in close clumps develop one-sided crowns except at the very top.

Photosynthesis is thus limited to one side of the tree.

4. The dormant side of the tree corresponds to the side having no branches, bearing out the theory that peripheral distribution of food materials is quite limited.
5. Should a tree be allowed more light, permitting the development of new branches toward the previously branchless side, continuous ring development is resumed.
6. Each case of discontinuous ring growth in this study was an abrupt change from normal ring development, and in each case was found to be associated with the loss of or serious injury to a large portion of the tree top; the anomalous growth extended the entire length and on the same side of the trunk to the injury in the top.
7. Loss of or injury to the tree top is traceable to the girdling work of rodents—rats or squirrels.

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ACCELERATION OF GROWTH IN WESTERN YELLOW PINE STANDS AFTER CUTTING

By Herman Krauch,

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In cutting western yellow pine in the national forests of the Southwest, no large mature trees are reserved unless they are needed for seed. Relatively young trees are preferred because they involve less risk, and until recently they were thought to be as good seed producers as those of advanced age. But Pearson[1] has shown that it takes large trees to produce quantity of seed and that immature trees are, as a rule, less effective in reseeding than mature ones of the same diameter. He figures that where reproduction is lacking at the time of cutting, an average minimum of four trees above 20 inches in diameter to the acre is needed to insure restocking. With such a high diameter limit some of the trees reserved must be mature, because immature trees above 20 inches in diameter are seldom present in sufficient numbers.

From a silvicultural standpoint the reservation of large trees for seed is obviously desirable. But outside of the acknowledged need of a maximum cut per acre to justify logging, the question arises whether the retention of large and especially of mature trees, is economically justified. Some of the trees will die before the next cut can be made, and unless the corresponding volume is replaced by the increment of surviving trees, a reduction in wood capital as well as a financial loss is entailed. Investigation shows that the growth of large trees becomes greatly accelerated after part of the stand has been cut. Whether the increment put on by the surviving trees may be sufficient to offset mortality cannot be definitely stated, however, until more data have been obtained. Meanwhile, facts revealed by a recent investigation justify from a different standpoint the conclusion reached by Pearson with reference to the kind of trees required for seed.

The investigation in question was conducted on an area which had been logged about 28 years ago, and which lies about one mile west of the Southwestern Forest Experiment Station. The site is typical of western yellow pine, although the large number of stumps left indicate that the stand was somewhat heavier than the average for this region. The land was private property at the time of logging and most of the

[1]"Natural Reproduction of Western Yellow Pine in the Southwest." By G. A. Pearson, U. S. Dept. of Agr., Bul. 1105.

merchantable timber was cut; nevertheless, fairly good seed trees were left and of these a number were selected for growth analysis, cores being extracted from them with an accretion borer.

The data were obtained from 106 trees ranging between 15 and 26 inches in diameter and around 200 years of age at the time of study. In selecting the trees, care was taken to choose only those that were likely to be benefited by cutting part of the stand. In the open yellow pine stands of this region the growth response is induced by reducing competition for soil moisture more than by an increase of light; in fact, there is often no apparent change caused by the latter factor. It was found that the cutting of trees which stand over 75 feet away from those retained has little effect on the acceleration of growth of the latter and that the degree of acceleration varies in inverse ratio to the distance of these from the stumps of trees cut. Consequently the trees selected for analysis were those which formerly constituted part of a group, or isolated trees near which other individuals or groups of trees had stood. Other factors affecting growth are length, width, and density of crown, and these were also considered in the selection. So far as possible only healthy trees with normally developed crowns were chosen.

Table 1 shows a tremendous increase in diameter during the 25-year period after logging. The average increase of 45 trees between 15 and 20 inches in diameter was 4.43 inches; for 61 trees between 21 and 26 inches it was 5.75 inches. The growth during a corresponding period before cutting was only 0.97 inches and 1.37 inches for these two groups respectively. The corresponding percentages of difference in diameter growth between the 25-year periods before and after cutting average 358 and 320; expressed in basal area this amounts to differences of 453 and 410 percent for the two groups concerned.

Table 2 shows the average growth of trees entirely isolated after logging, whereas in Table 1 those partly isolated are also included. It will be noted that in 25 years after cutting the diameter growth was as great as in 93 years before cutting. The number of years involved in the growth before cutting is based on an actual count and not on the extrapolated values for 25 years alone; it therefore shows for how long a period the growth had slowed up before the stand was cut.

TABLE I.

(*Average Growth by Diameter Classess.*)

	Diameter Class	Diameter Increase[1] Before Cutting	Diameter Increase[1] After Cutting	Difference		Trees as Basis
	Inches	Inches	Inches	Inches	Per Cent	No.
	15	0.78	5.01	4.23	542	4
	16	0.74	3.19	2.45	331	6
	17	0.78	5.67	4.89	627	6
	18	1.06	5.06	4.00	377	8
	19	1.04	4.14	3.10	298	11
	20	1.14	4.03	2.89	253	10
						45
Weighted Average	18.0	0.97	4.43	3.47	358	—
Percentage of	difference	on basis of	basal area	453		—
	21	1.18	4.85	3.67	311	21
	22	1.15	5.63	4.49	390	10
	23	1.16	6.40	5.24	452	8
	24	1.70	6.47	4.77	281	11
	25	1.71	6.57	4.86	264	5
	26	1.84	6.26	4.42	241	6
						61
Weighted Average	22.8	1.37	5.75	4.38	320	—
Percentage of difference on basis of basal area 410						—

[1]For a period of 25 years before cutting and 25 years after cutting.

TABLE II.

(*Average Growth of Isolated Trees.*)

	Diameter Class	Diameter Increase[1] Before Cutting	Diameter Increase[1] After Cutting	Difference		Years required before cutting to grow equivalent of 25 years after cutting	Trees as Basis
	Inches	Inches	Inches	Inches	Per Cent		No.
	18	1.35	5.03	3.68	272	91	2
	19	1.10	3.72	2.62	238	81	5
	20	1.00	3.93	2.92	292	84	4
	21	1.09	4.56	3.47	318	89	10
	22	0.97	5.92	4.96	511	113	5
	23	1.21	6.91	5.70	471	108	5
	24	1.72	6.00	4.28	249	89	4
							35
Weighted Average	21.2	1.17	5.09	3.92	335	93	—
Percentage of difference on basis of basal area 348						—	—

[1]For a period of 25 years before cutting and 25 years after cutting.

However, it is not so much the growth before cutting as that obtained after cutting which demands our attention. The trees analyzed grew an average of almost five inches. Obviously, for a 25-year period, this is good growth. How much longer the present rate will be maintained cannot be told; but, judging from the fact that during the last few years there has been very little falling off, it is reasonable to assume that the trees will continue to grow at a rapid rate for many years more.

Under the present system of cutting we probably cannot profitably return for a second cut on this area within 75 years, and this is too long a period for which to make predictions of eventual yield. With lighter cutting, the cutting cycle could probably have been reduced to 50 years, which would avoid the loss of those large trees that will not survive the longer interval. This loss will be averted, however, if with a change in economic conditions it will be possible to salvage the trees that must be cut before the expiration of the cutting cycle. A factor which will justify salvage is the quality increment which results from the growth of large, well-pruned boles.

Owing to a lack of other data, the foregoing deductions are necessarily somewhat speculative. In the first place it is not known to what extent acceleration occurs on the bole at points other than at breast height, although data obtained by boring 15 trees at a point 18 feet from the ground in addition to breast height show that there was an average increase of 5.30 inches in 25 years at 18 feet from the ground as compared with an increase of 6.30 inches at breast height; a difference of one inch or about 19% in favor of the latter. In the second place information is needed showing the true relationship between mortality and increment during a period corresponding to the length of cutting cycles. This will be obtained from permanent sample plots; but we must wait until the required time has elapsed before it will be available.

That mature trees respond greatly in growth as a result of cutting part of the stand is proved by the results obtained in the present investigation. Whenever mature trees are needed for seed we should not hesitate to reserve them, taking care to select as far as possible only trees which are vigorous and which have well developed crowns, so that besides a good seed supply the highest possible returns in wood increment may be obtained.

HOW FIRE CHANGES FOREST TYPES

By E. F. Brouse[1]

It is the purpose of this paper to show how forest fires change the type of forest growth found upon specific forest areas. There are a number of factors which may enter into this change, which in some cases expedite the transition and in other cases retard it. The rate of change depends, to a large extent, upon the fertility and mositure of the soil, the type of forest that is present and the number of times the area has been burned. The fertility of the soil determines, to a large extent, the type of forest that is present. The moisture depends upon the density of forest cover on the soil which in turn is largely dependent upon the presence or absence of forest fires. There is a certain inter-relationship between soil, moisture and forest cover which hinges in a large measure upon the ravages of forest fires.

Forest fires change the existing forest type which may or may not return directly upon a specific area. The latter probably only happens in the case of successive forest fires extending over a long period of years. The forest will then be made up of inferior species no matter if kept free from fire or not. This apparent regression to inferior trees probably only occurs when the forest is removed by the axe and the understory is also later destroyed by fire.

The transition from a temporary to a permanent type takes place gradually. Forest destruction is inconsistent with natural changes and will always keep a type temporary or cause it to revert to a temporary one. The exact rate of change varies with many conditions and also in each specific forest area. If the soil and moisture conditions are right and fires are kept out it may be assumed that the change will be rapid. However, if the soil is poor and all other conditions are adverse to tree growth, the usual temporary type becomes rather permanent for it may take many years to develop a perceptible change.

A careful examination around the margin of a burned forest will show the kind of trees that are working their way in on the burned area. By the time the short-lived aspens, fire cherry and scrub oak have made a covering on the burned land, the good trees from the surrounding unburned forests will become re-established in the new forest. The favorable change is made possible by seeds of conifers carried by the winds, berries by the birds, and nuts and acorns by the squirrels. The resulting tree mixture may vary little or much from

[1]Read before the Allegheny Section, Society of American Foresters, Feb. 29, 1924, at Harrisburg, Pa.

the kinds that grew there before the fire. The course of development may be interrupted or deflected. It may be retarded or hastened, or it may be delayed for a long period of time but whenever a change does occur it is always in the direction of the permanent forest type.

In order to determine the transition the various forest types undergo, data were collected throughout Pennsylvania on more than 40 plots, each of which was at least an eighth of an acre in area. The plots were located in carefully selected places so that the many factors may be taken into consideration that deal with the change of forest types when destroyed by fire and similar ones (that were) unburned.

A sample plot was laid off on Second Mountain near Coburn in the Penn Forest District. It is located on an area which originally supported a good growth of pitch pine and chestnut, and some rock oak. The pitch pine was cut between 1880-1885. The chestnut was never lumbered, but was killed by repeated fires after the cutting of the pitch pine. From 1885 to 1909 the area was burned every 2 or 3 years, chiefly to increase the huckleberry crop. In 1909 the area burned for the last time. During the spring of 1910 plantations of white pine, Scotch pine, red pine and Jack pine were established. The soil is a well drained sandy loam. The exposure is southern.

The following table gives the number of trees of the different species per acre by inch classes found on the area 13 years after the plantations were established, and 14 years after the last fire burned over the area:

TABLE I

Kind of Trees	Inch Classes					Number of Trees	Per Cent of Trees	Average Height (Feet)
	Under 0.5	1	2	3	4			
*Scrub Oak	...	...	...	..	..	912	38.9	6
**White Pine	...	...	...	..	..	556	23.7	5
*Chestnut	...	...	...	..	..	220	9.3	7
Rock Oak	...	52	100	36	4	192	8.2	15
Red Maple	48	48	64	..	..	160	6.8	7
Aspen	16	60	12	4	..	92	3.9	12
Sassafras	40	28	16	..	..	84	3.6	7
White Oak	16	8	8	..	..	32	1.4	10
Black Oak	8	16	8	..	..	32	1.4	7
Red Oak	16	8	4	4	..	32	1.4	8
Scarlet Oak	8	4	...	4	..	16	.7	7
Juneberry	8	8	4	..	..	16	.7	8
Total	160	232	212	48	4	2,344	100.0	..

*The total number of sprouts was determined by counting the stools and multiplying by the average number of sprouts to a stool.

**Trees in plantation.

The scrub oak and other temporary species are being suppressed rapidly on this area. The area directly across the road which has been burned over twice since the present plot was last burned, shows a growth of approximately 5,300 scrub oak sprouts per acre, which is not an extra large number for a typical scrub oak area.

There are only about 1-7 the number of scrub oak sprouts and 31 times the number of valuable species of trees growing on the area that was not burned compared with the area that has been burned twice. All of this change has taken place in 14 years. The writer believes that in five more years very little scrub oak will be present on the unburned area.

The number of valuable trees per acre on the unburned area (including the white pine in plantation and excluding the blighted chestnut) is now 1,020. Excluding the white pine in plantation, the valuable trees number 464 per acre. The number of trees of natural origin present on the area may seem rather small for a 14-year old stand, but the growth and the establishment is rather good in spite of the impoverished soil and poor moisture conditions.

While the white pine in the plantation, of which only 50 per cent of the trees are still living, has not made rapid height growth, however, the trees are now ready to grow rapidly. The average height of the white pine is 5 feet. About 30 per cent of the trees will average more than 7 feet. Some of them are suppressed badly and have grown only a little more than 1 foot in the 13 years.

Table I shows that the species are now beginning to compete with species. The permanent type of trees are dominating over all the members of the temporary type and the latter will soon be shaded out. It is becoming evident that the rock oak, white oak, red maple and some of the white pines have a commanding lead in height growth, and presently will take complete control of the area.

Plot II was laid off on an area adjacent to Plot I. The conditions on the two plots are similar excepting that Plot I was burned over twice in addition to the burn of 1909. These burns took place in 1913 and 1920.

The following table, based on data collected in midsummer of 1923, gives the number and kind of trees per acre on the area:

TABLE II

Species	Average Number of Shoots Per Stool	Total Number of Trees Per Acre	Average Height of Trees (Feet)	Per Cent of Trees
Scrub Oak	15	5,340	4	74.1
Rock Oak	6	744	6	10.4
Chestnut	6	504	7	6.9
Red Maple	3	216	5	2.9
Sassafras	2	200	4	2.8
Aspen	..	164	8	2.3
Red Oak	3	36	5	.4
White Oak	3	12	4	.2
Total	..	7,216	..	100.0

A comparison between Table I and Table II shows that only 46.4 per cent of the trees are temporary after the absence of fires for 14 years, while three years after a fire 79.2 per cent of the trees were temporary.

Scrub oak is a very intolerant tree. It cannot compete with any tree growth that overtops it. In time it gives over an area entirely to other trees. The foregoing table shows that the number of scrub oak per acre was reduced 32.8 per cent in 14 years. This indicates clearly its temporary characteristic and short duration. During the same period the number of valuable species, excluding all temporary trees, increased from 13.9 to 43.6 per cent.

Scrub oak during the second and third year after a fire is at the height of its reign, depending, however, upon previous fires, soil, moisture, etc. At that time it probably controls the area and is more flourishing than during any other period of its life. It recovers more quickly from the effects of fire and makes nearly as much height growth in the first few years after a fire as it does during the remainder of its life. The foliage during the early stages of its development is more dense and consequently the shade is more detrimental to other trees that try to grow with it. After the fifth year the vigor of scrub oak begins to decline, the rate depending upon the number of other species which have surpassed it in height growth.

The following data on a plot located in Cooper's Gap in the Penn Forest District shows the elimination of the temporary type:

TABLE III

Species	Inch Classes									Total Number of Trees Per Acre	Basal Area of Trees Per Acre (Sq. Ft.)	Per Cent of Total Basal Area
	4	6	8	10	12	14	16	18	20			
Red Maple. . .	28	20	6	2	2	2	2	. .	. .	62	34.3	21.3
White Oak. . . .	12	10	8	6	4	2	. .	2	. .	44	21.0	13.1
Rock Oak. . . .	2	4	8	6	6	6	6	2	2	42	20.7	12.8
White Pine. . .	. .	6	8	12	8	. .	. .	. .	. .	34	18.3	11.3
*Chestnut.	8	. .	6	6	. .	4	2	2	. .	28	16.8	10.5
Red Oak.	. .	. .	. .	. .	6	4	. .	4	4	18	16.6	10.4
Black Gum. . .	. .	. .	. .	4	2	2	4	. .	. .	12	11.4	7.2
Hickory.	2	. .	2	2	2	. .	. .	2	. .	10	8.6	5.3
Scarlet Oak. . .	. .	. .	. .	. .	2	4	2	. .	. .	8	7.0	4.4
Cucumber. . . .	. .	2	2	2	2	. .	. .	. .	. .	8	3.7	2.4
Hemlock.	. .	2	2	. .	. .	. .	. .	. .	. .	4	1.1	.6
Pitch Pine. . . .	. .	. .	. .	2	. .	. .	. .	. .	. .	2	1.1	.6
Dogwood.	2	. .	. .	. .	. .	. .	. .	. .	. .	2	.2	.1
Total.	54	44	42	42	34	24	16	12	6	274	160.8	100.0

*Trees dead or nearly so.

A special search was made for scrub oak and other temporary trees on this plot but without success. The characteristic temporary type has disappeared entirely. The area has not been subjected to the hazards which keep the forest stocked with inferior species. The average age of the stand is 50 years. The oldest residents in the section can not remember of a fire burning in this locality. The trees do not show any fire scars nor are there any other indications that fire has burned over the tract.

Virtually all of the trees on this plot are of seedling origin. They represent what was the advanced undergrowth at the time of lumbering, which took place about 1880. The shaded undergrowth presents a sparse growth of witch-hazel, mountain laurel, red maple and black gum. The average height of the stand is 65-70 feet. Moisture and soil conditions are better than the average of the locality.

There are 63 cords of wood per acre in this stand. The stand grew at the rate of 1.26 cords per acre per year. Although the soil and moisture conditions are better than the average, had fire burned over the area as it did on an area not far distant, the temporary type of forest would still prevail.

These examples show clearly the succession of forest growth to a permanent type under favorable conditions. At least 70 per cent of this stand is made up of good permanent type trees (this excludes the blighted chestnut). A higher percentage than this is seldom found in natural growth without the aid of thinnings.

It is not necessary to wait many years before the permanent type of trees claim an area. This change will often come about in 15 years.

Table IV gives the result of a count made in a representative 15-year old stand:

TABLE IV

Species	Inch Classes				Total Number of Trees Per Acre	Per Cent	Basal Area Per Acre (Sq. Ft.)	Per Cent of Total Basal Area
	1	2	3	4				
Rock Oak	432	408	88	40	968	35.9	19.3	54.2
Red Maple	816	64	..	..	880	32.7	6.4	17.6
Chestnut	208	120	..	..	328	12.3	3.8	10.9
Sassafras	160	24	8	..	192	7.2	2.2	6.2
Red Oak	88	56	8	..	152	5.9	1.8	5.3
Black Birch	40	48	..	..	88	3.3	1.3	3.6
Black Gum	64	...	..	..	64	2.4	.4	1.1
Black Oak	...	...	8	..	8	.3	.4	1.1
Total	1,808	720	112	40	2,680	100.0	35.6	100.0

If the trees are excluded from the foregoing table that will amount to little as timber trees (including the chestnut), there will still be left 78.1 per cent of the stand. The oaks will feature the final stand for they now make up 42.1 per cent based on the number of trees. If the percentage is based on the basal area, then the oaks make up 61.5 per cent of the stand, and only 17.3 per cent is made up of what may be classed as a temporary or inferior type of trees.

This plot was laid out on a rocky mountain slope of 20 degrees with a northern exposure. This area shows a particularly fine growth of rock oak coppice. There is very little undergrowth present. An estimate shows that this stand grew 4.3 cords in 15 years or slightly less than a fourth cord per acre per year. While small in amount yet this growth in volume may be considered good because of the adverse soil and moisture conditions. Also, the trees on this area have not yet reached the age at which they make their greatest volume growth.

During the spring of 1923, 98.5 per cent of this stand was wiped out by fire. The only trees remaining were a few of the larger rock oak, which seemed to be favored and protected by large rocks. This fire covered an area of 250 acres and burned severely. In the middle of the summer of 1923 there was evidence of chestnut and rock oak sprouts shooting forth. It is not likely that immediately following this fire the temporary trees would entirely claim this area, however, after several fires the temporary type would again become predominant.

In a different locality where fires have burned at frequent intervals for many years it can be seen clearly that the temporary trees will not entirely lose their hold in a stand in 8 to 10 years. This can best be substantiated by the subjoining table:

TABLE V

Species	Number of Trees Per Acre	Per Cent of Trees	Average Height (Feet)
Scarlet and Black Oak	5,372	40.5	8.5
Scrub Oak	3,915	29.3	4.5
Chestnut	1,955	14.6	8.5
Red Maple	1,394	10.4	7.0
White Oak	697	5.2	8.0
Total	13,333	100.0	...

The trees of value are white, black and scarlet oak and red maple which make up 56.1 per cent of the stand. At the end of 10 years nearly 30 per cent of the stand is made up of temporary species. Other stands growing under more favorable conditions show that the temporary trees are in many cases absent at this age.

It is not expected 25 or 30 years will be required to reclaim an area made up of permanent type trees that has recently been burned or destroyed. For example, one stand that was 10-12 years old and then burned over, was found to contain only 4.7 per cent of temporary trees a year after the fire. The better the condition and the more advanced the permanent type of forest, the less likely will there occur an appreciable change in the forest make-up when devastation does come.

A plot was laid out on top of Broad Mountain near Lansford in the Weiser Forest District located in a stand 8 to 10 years old that has been burned over frequently for many years and was again burned over by a severe fire in the spring of 1922. The tree growth was all killed. During the summer of 1923 a count of the new sprouts gave the following results:

TABLE VI

Species	Number of Trees Per Acre	Per Cent of Trees
Scrub Oak	41,325	90.6
Scarlet Oak	3,536	7.8
White Oak	281	.6
Red Maple	272	.6
Rock Oak	85	.2
Black Oak	51	.1
Aspen	34	.1
Total	45,584	100.0

The foregoing shows the predominance of scrub oak—a temporary type of tree—when the area is burned over frequently. This fire increased the number of trees in the temporary type 61.3 per cent.

The sprout growth, which is one year old, averages 2.5 feet in height. If this area is burned over within the next 2 or 3 years it will take a long time for it to recover. The table shows that there are a sufficient number of valuable trees per acre but because of the abundance of scrub oak it is going to be difficult for them to choke it out.

The following summary tabulation is based on the results of tree measurements in plots with varying soil conditions and located in various parts of the State. The areas upon which this table is based have been burned over frequently during previous years. It shows the per cent of trees of the temporary type in the oak forest that is present for diffrent aged stands.

TABLE VII

Age of Trees (Years)	Per Cent of Temporary Type Trees
1	78.
2 to 3	69.
7 to 8	40.
10 to 12	19.
15 to 17	11.
30	Negligible

The percentage of temporary trees in a stand varies widely. Wide variation may be encountered even on different plots on the same burn. This may be due to natural and physical features peculiar to a particular location. There can be no general group of figures that will be applicable to each specific area.

Averages of the beech, birch, maple type forest show that there is a higher percentage of temporary trees per acre up to the twelfth year than in the rock oak-pitch pine type. From this time on the decline in the numbers is more rapid and the complete absence comes at an earlier age because the beech, birch and maple trees establish themselves more readily and usually grow faster.

The temporary type in a white pine-hemlock forest controls the area for a greater number of years than any other forest type in Pennsylvania. This is due to their slow starting or establishment, particularly the hemlock. When an area is lumbered and fires then burn over it, the young trees are killed and any seed that may be there is consumed. This means that these species must come back upon the area from the outside, for they do not sprout from the stump like many of the hardwoods. This process may delay for many years the coming in of the permanent forest type. This is the reason it is so often said that conifers do not follow conifers but are followed by hardwoods. In reality conifers will follow conifers but hardwoods are quicker to take advantage of any opportunity they are offered and particularly after a fire or clear-cutting.

CONCLUSIONS

1. Forest types change from the temporary to the permanent type but do not regress naturally until the climax type is reachea.

2. The rate at which the change is brought about depends, to a large extent, upon the fertility and moisture of the soil, the number of times the area has previously been burned, also the severity of the burns and the type of forest that is present on an area.

3. Forest fires largely destroy the existing forest type which may or may not return directly upon a specific area. The latter happens in case of successive forest fires extending over a long period of years. The type will then ultimately result in a stand made up of inferior species.

4. The temporary or scrub type is at the height of its reign from the third to the fifth year after a fire, depending upon the occurrence of previous fires, nature of soil, soil moisture and other influencing factors. From the fifth year on the vigor seems to decline, depending upon the number of other species which at this time surpassed the temporary type in height growth and offer resistance to its further development.

5. The temporary type of a white pine-hemlock forest controls the area for a longer period of time than any other temporary type in Pennsylvania. This is because of the comparatively slow establishment of these species. Where birch, beech and maple make up part of the white pine-hemlock forest it is only a short time until the hardwoods are the controlling trees. The fire cherry and aspens are found in greater numbers than other temporary trees in the early years after the devastation. However, these are not nearly so stubborn as scrub oak, consequently, they disappear at an earlier age after the establishment of permanent trees.

6. When the growth on an area has advanced to the permanent type it is not likely that a single fire will revert it entirely to an inferior one. If several fires followed in close succession then the type would become essentially temporary. For example, the second year after a fire in a good 15-year old stand of rock oak, red oak, black birch and red maple there was found to be only 11.4 per cent of the stand made up of temporary trees. If this fire were followed by another within several years, the percentage of temporary trees would greatly increase.

7. The transition from a temporary to a permanent type takes place gradually. The exact rate of change varies with many conditions and also different types of stands. In the average stand it may be expected that the temporary type will be absent or nearly so from the twentieth to the twenty-fifth year after devastation.

THE FIRE PROTECTIVE ASSOCIATIONS OF IDAHO AND MONTANA[1]

By R. N. Cunningham,

Weeks Law Inspector, U. S. Forest Service

At a time when so much attention is being directed to the newly developed State activities in forestry and the slowly awakening public interest is being spurred by pictures of private devastation, we are apt to overlook some of the things which have been accomplished by private enterprise.

Organized fire protection started in the Northwest before any very thorough plans had been devised for the protection of the National Forests, and at least a decade before there was any appreciable popular demand for the practice of forestry on private land. Some of this work was done as early as 1905 in Idaho.

During the latter part of July, that year, forest fires became quite prevalent throughout the Coeur d'Alene district and a crude attempt at cooperation was made. Some similar work was done in the Clearwater country this same season. Incomplete as it was, this cooperation showed plainly the advantages to be gained by teamwork, and in June, 1906, the Coeur d'Alene Association was formed.

This movement, started by a few Coeur d'Alene lumbermen, quickly spread throughout the Northwest. Within a year, three other Associations were formed in North Idaho, and timber owners of Washington, Oregon, Montana, and California soon followed suit.

As the work progressed in Idaho, the necessity for some legislation became evident, and at the 1907 Legislature, Mr. J. P. Fallon of Kootenai County introduced the Fallon Fire Law, which was drawn up by the Associations and provides for local administration under the authority of the State. Some minor amendments were made in 1909, but otherwise the law has remained the same up to the present time.

In the meanwhile, the associations have worked hand in hand with the Federal Forest Service in devising means and methods of making the forests safe from fire and in building up a public sentiment favorable to fire prevention. Too much cannot be said in commending the

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[1]Read before the Northern Rocky Mountain Section, Society of American Foresters, March 12, 1923.

men who have been behind this movement, for the ability, energy, and spirit which has been displayed in the work.

The Idaho Associations have kept quite complete records of the work done since 1910, and it might be well at this time to consider what has been accomplished to date and the present tendencies as revealed by these records.

The chief points of interest are Cost of Protection, Acreage burned, and Timber destroyed (records are not complete as to other losses). In the following tables, yearly averages for three four-year periods (1911-14, 1915-18, and 1919-22) are set up side by side, to show in a general way the changes which have occurred in 12 years.

TABLE I

Annual Cost per Acre

Association	1911-14	1915-18	1919-22
Clearwater	\$ .05½	\$ .05	\$ .11
Potlatch	.08¾	.05	.15
Coeur d'Alene	.04	.04	.23
Pend Oreille	.02½	.04	.12
Average	\$ .05	\$ .04½	\$ .15

TABLE II

Average Acreage burned per Season

Association	1911-14	1915-18	1919-22
Clearwater	2,551	2,886	2,219
Potlatch	5,218	547	5,182
Coeur d'Alene	1,293	2,512	8,947
Pend Oreille	3,855	9,379	21,068
Total Annual	12,917	15,324	37,416

TABLE III

Average MBF Timber burned per Season

Association	1911-14	1915-18	1919-22
Clearwater	1,360	568	10,580
Potlatch	27,818	606	5,386
Coeur d'Alene	2,941	2,742	42,509
Pend Oreille	288	896	11,307
Total Annual	32,407	4,812	69,782

In comparing the last period with either of the previous ones, it will be seen that costs have trebled while damage and acreage burned have more than doubled.

Undoubtedly, climatic conditions have been a very important factor in bringing about this condition. High cost of labor and materials has also influenced the cost of protection. These things are almost self-evident, and have been stressed in almost every discussion in which private timber protection has been considered. There are, at the same time, other factors not quite so apparent and consequently often overlooked which have helped very materially to bring about the conditions just noted.

It is a well-known fact that the fire hazard on forest land in this region is very greatly increased when the land is cut over. The mere opening up of the stand has an immediate effect, and when logging debris is left on the ground the inflammability is very greatly increased. Judging from the average size of fires originating in green timber and on cut-over land in the Pend Oreille territory, the ratio of inflammability is about one to five. Slashings on the same scale rate about twenty.[2]

Since the Associations were organized, the acreage of cut-over and burned land in the areas protected has increased probably 500,000 acres, and it is certain that the inflammability has also increased. If we represent by 100% the inflammability of this entire area, 2,400,000 acres, while it is all virgin timber,—in 1906 and '07, when the Associations were formed, it would be 150% on account of the 300,000 acres cut over by that time. At the present time, we would have an inflammability index of 233% if the inflammability ratios mentioned in the preceding paragraph are correct: that is, if cut-over land is five times as inflammable as green timber. This is making no allowances for areas of unburned slash which will raise the danger still more. In another ten years the index will be at least 300%, even if cutting progresses no more rapidly than at present, and assuming that all slash will be disposed of.

From the operating owner's standpoint this trend is still more serious, in that the timber which he desires to protect is diminishing in quantity. His cost per thousand increases not only because the inflammability and cost per acre is greater than before, but also because his stand per acre is less.

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[2]Computed from annual reports of the Coeur d'Alene and Pend Oreille T. P. A. R. N. C., 1921.
5 yr. Av. fire originating in slash areas, 594 acres.
Av. fire in cut, burned or brush areas, 144 acres.
Other, 28 acres.

A group of thirteen large owners in Idaho control over half of the contributing acreage in the Associations and own approximately one-third of the standing timber. Together with the State, they have spent $1,800,000 for protection. Charged against their present holdings (25 billion feet on 1,500,000 acres), this represents $1.20 per acre, or 7 cents per thousand board feet.

Protection costs are properly a charge against standing stumpage. The investments are made to protect this standing timber and for practically no other purpose. If the investments made by these thirteen companies and the State are considered in this way and are each year prorated against the total stand and carried forward at six per cent interest until the timber is cut, the charge against the 25 billion remaining amounts now to about $2,250,000, or 9 cents per thousand feet ($1.50 per acre).[3] This would not appear to be a very burdensome charge yet, but it is rather discouraging to note that this charge against stumpage has been more than doubling every five years, and the rate of increase is almost certain to be still greater in the future.

Accumulated Charges against Standing Stumpage

To 1910	.9 cents per M.
To 1915	2.4 cents per M.
To 1920	6.3 cents per M.
To 1925 (est.)	13.3 cents per M.

It seems logical to conclude that before the entire virgin stand is cut out some thirty years hence, the carrying charge against the remaining stumpage will have become so great that there will necessarily be a big retrenchment in the protection work of the timber owners, and eventually a complete abandonment of organized protection. When this will take place is a doubtful matter, but well-informed men have placed the date at no more than ten years from now for certain districts. Certainly there will be districts or parts of districts where the owners will soon decide that the value of the destructible resources is not sufficient to justify protection at the present high and increasing rate.

The normal tendency for the next decade would probably have these characteristics:

(1) Increasing hazard due to cutting of virgin timber.

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[3]Note.—A total of $277,500 has been charged off for timber which has been cut; $2,250,000 is a charge against timber remaining.

(2) Stationary or only slightly increased expenditures by the large owners. The protection requirements will be greater, but the protection work will be more concentrated to valuable areas.

(3) Falling off in membership of associations, especially small owners. Cutting will lead to this result, since when a man has cut all, or even a large part, of his timber, he will find it to his advantage to withdraw, and there is nothing to prevent him from doing so. Even at this time, less than 50% of the area which should be protected in North Idaho is paying anything toward the cost of patrol. In the Clearwater, which is almost a virgin stand, the warden estimated in 1919 that $13,700 out of a total of $21,000 was spent to protect timber belonging to persons who were not members and who paid nothing toward the expense of fighting the fires.

(4) Serious reduction in area protected and in quality of protection.

These developments are looked upon as the natural tendency of the present situation. Actual events in certain sections would justify this as a prophecy, except for the fact that public interests cannot afford to permit such a condition to come about, and this fact is slowly becoming recognized.

The Government Weeks Law allotment is one attempt to counteract the receding tendency, and State organizations are beginning to bolster up the weak places in private patrol.

The need of State leadership in this work is very pronounced. The evils in the present situation which have been emphasized in this discussion, can be corrected by State action and by State action alone.

We have seen that in the volunteer patrol system, the distribution of the burden is not equitable, in that many land owners, taking advantage of strategic locations, are riding free at the expense of other owners less fortunately located. This can be corrected by a compulsory patrol law.

The increasing hazard can be offset to a large extent by proper disposal of slash. Here, State officials can do a great deal by demonstration work and by getting the various interests together in a friendly way to work out the problems of interest to all.

As districts become cut over, it is going to become necessary for the State to do more and more in the way of direct protection. As the private owners' interests get less, the public interest becomes relatively greater, and when private protection begins to fail, the State must take up the slack. The federal government should have a hand in this finan-

cially, and undoubtedly will share the expense in a generous way, but the actual leadership must come from the State.

The way in which the State should share in the protection work is a debatable subject. On the one hand, it can gradually absorb the protection work until finally it controls the entire machine; or, on the other, the Associations can be strengthened and expanded by liberal financial assistance and thorough supervision. Probably in practice, these two schemes can be worked in more or less together in ways to fit varying conditions.

The Association organizations, of which the non-political nature is an attribute of no small importance, can be depended upon, with some State and Federal assistance, to look after the districts where merchantable timber is still a large factor. In cut-over districts, an organization under the direct supervision of the State will probably be desirable.

Thus, in the critical items of cost and damage on which the volunteer association scheme of protection threatens to break up within fifteen years, the State is in a position to stabilize and put protection on a healthy basis. In costs, by distributing the load and assisting with the cut-over land problem; in damage, by encouraging the reduction of slash hazards and strengthening and extending protection in general, the help of the State is needed. With this help, I see no reason why the Associations which have been such a big factor in the situation to date cannot continue to play a big part in a program of forestry.

A NEW TECHNIQUE FOR GROWTH STUDIES BY STEM ANALYSES

By Donald Bruce,

Division of Forestry, University of California

In the infancy of American forestry the study of growth by stem analysis was considered one of the most important phases of a forest investigative program. Thousands of tree stems were dissected and measured, and although a clear conception of the end sought was often lacking, yet definite progress was made in improving the technique of the computational work involved. After a few years a reaction set in. All the inherent weaknesses of the method became appreciated and attention was turned to methods of study that promised more immediate answers to urgent problems. It seems that perhaps, as is so often the case, the pendulum has now swung too far back, and that on account of this more recent neglect of stem analysis work our forest knowledge lacks today important facts concerning tree growth. I believe the future will see a revival of interest therein.

The earliest work was handled strictly along lines imported from Europe. Very shortly, however, Mlodjiansky proposed his abridged method familiar to all students of mensuration,[1] and a little later Graves suggested his modification thereof, which combined and simplified the resulting graphs. These improvements in technique resulted in an enormous saving in computational labor, and sacrificed little or nothing in accuracy.[2]

While stem analyses were becoming unpopular, still further attempts were made to lessen the work connected therewith. These involved the use of volume tables, and the consequent erroneous assumption that except in so far as age is correlated with diameter and height, form is independent of age. In the most extreme cases, the stem analysis is reduced to little more than a stump analysis supplemented by curves having little or nothing to do with growth, and the final results, according to experience, may be anything from closely approximate to completely misleading. For most problems that require stem analyses at all these later approximation methods are inadequate.

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[1]Chapman, H. H., Forest Mensuration, pp. 379 ff.

[2]An exception to this statement should probably be made in cases where trees studied are somewhat uneven-aged and where certain difficulties in curve drawing are apt, in consequence, to develop.

In a recent study of redwood a new technique was developed which apparently results in a great saving in both field and office work, without appreciable sacrifice in accuracy. It is based on anamorphosis,[3] a graphic process in which a shifting of the graduations of the horizontal axis converts a series of harmonized curves into a series of straight lines. The curves of the typical Graves-Mlodjiansky graph appear to

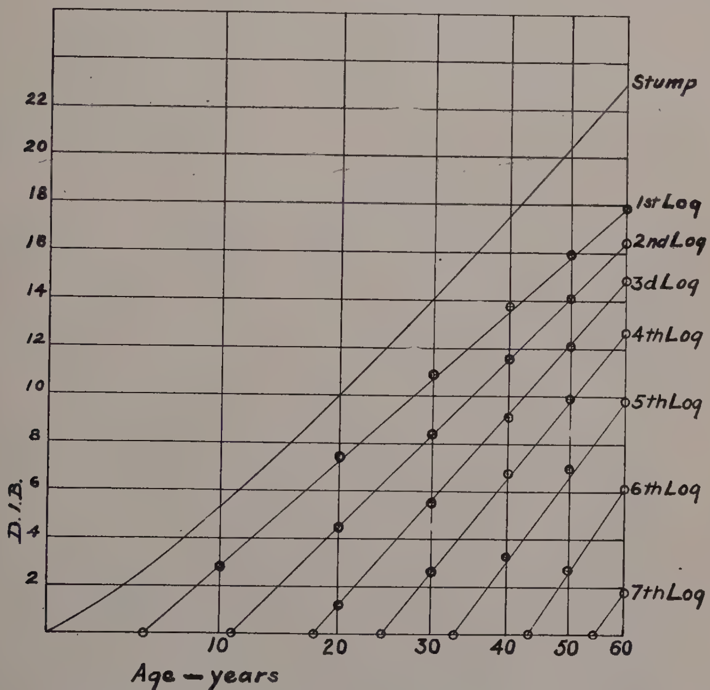

Figure 1.—Anamorphosed graph of diameter growth by 16 foot logs: 27 dominant redwood.

be susceptible to this treatment. Fig. 1 illustrates the resulting graph in the case of 27 dominant redwoods. The small circles represent the values as worked out according to the conventional technique, and their proximity to the straight lines indicate the practical identity of the results of the two methods. It will be seen that the stump curve alone is refractory, and this is readily explained on the basis of the influence thereon of root swelling. It is obviously preferable, therefore, to graduate the horizontal axis by means of the diameter-growth curve

[3]The fundamental principles of anamorphosis are explained in "Anamorphosis and Its Use in Forest Graphics," Vol. XXI, No. 8, Dec., 1923, of this Journal.

at the lowest section available on the tree which is free from this influence.

The consequences of the applicability of anamorphosis to such curves are more far-reaching than would at first appear. If straight lines may be substituted for curves it is obvious that only two points are required to locate each with definiteness, providing, of course, that these two points be well established. Moreover, two points on each line are readily available, and with a minimum of labor, namely, its intersection, first with the horizontal axis and second with the vertical located at the age of the trees when cut. The former may be taken directly from a curve of height growth and the latter from an average taper curve of the trees studied. Both of these curves can be obtained with far less labor than is involved in complete stem analysis.

It will probably simplify this explanation to trace from beginning to end the several steps involved in the revised technique. These are as follows:

A. *Field Work*

1. A stump analysis of each tree (ring counts and decade measurements).
2. A section analysis of each tree at the lowest available section which is free from the influence of root swelling. This will normally be either 10 or 16 feet above the stump.
3. Ring counts, but without decade measurements, at additional sections on each tree. *These sections need not be at uniform height intervals nor at equivalent heights on the various trees.* Where the heights are fairly uniform and where the total number of trees available is large, it would doubtless be proper to take these measurements on sample trees only.
4. Taper measurements of each tree to the tip. These are preferably, but by no means necessarily, at uniform length intervals. These should be inside bark, but of course need not be on sawed sections.

These four steps complete the field work. It is obvious that considerable time will be saved over that involved in taking complete stem analyses, through the abandonment of the decade measurements, except on the first two sections. The fact, moreover, that above these sections the log lengths may be unequal, will also prove a great advantage in many cases, often permitting the securing of adequate data on timber felled and bucked for commercial purposes.

B. *Office Work*

5. A curve of height growth, using the data from step 3. Height should be treated as the independent variable.
6. A taper curve, using the data from step 4. Ascertainment of the average age (n) represented thereby, i. e., the average age of the trees when cut.
7. A curve of diameter growth at the lowest section free from the influence of root swelling, using the data from step 2. Let us assume that this is at 16 ft. from the stump.
8. A regraduation of the horizontal axis of the curve of step 7 so as to anamorphose this curve into a straight line.
9. Ascertainment from 5 of the average age at which trees reach 32 ft. in height, and the placing of a point at this age on the revised base line of graph 8. Ascertainment from 6 of the average d.i.b. at a point 32 ft. in height at n years of age. Plotting of a point representing this diameter above n years on the same graph. Connection of these points by a straight line which will represent the growth in diameter on the 32 foot section. Repetition of this process for the 48 foot and any other needed sections.
10. Addition of the curve of growth on the stump, using the data from step 1, but without any effort to force this into a straight line form. The final result will now look like Figure 1.
11. Calculation from the results of 10 of the volume at ten-year intervals in the usual way.

In the office work, the only additional labor is in the anamorphosis of one curve and in the drawing of one taper curve. The labor of preparing the growth curves at the upper sections is very considerably abridged. The net saving will obviously vary with the height of the trees and the height interval at which section curves are drawn. This saving, while sometimes very material, is undoubtedly of far less moment than that already described in the field work.

COMPUTATION OF TOTAL CUBIC CONTENTS OF TREES

By C. Edward Behre

The superiority of the cubic foot as a unit for measuring timber is well recognized and it is recommended that basic growth and yield tables be expressed in cubic feet for all management and scientific work. Dependable cubic foot volume tables are therefore necessary.

In the compilation and checking of cubic foot volume tables a question of accuracy arises which has not been seriously touched upon in the literature on the subject as far as I know. This is in regard to the method of computing the actual total cubic contents of the trees. In conventional instructions covering this point the stump is usually figured as a cylinder after allowing an arbitrary amount for the unusable portion, the intermediate sections of the stem as frustums of paraboloids by the Smalian formula and the tip as a cone. Results varying within a margin of 5 to 10% may be obtained in this procedure, depending upon the system used in sectioning the tree in the field and the method of handling the butt swell in the office.

If a given set of tree measurements are handled consistently a volume table worked up in the conventional manner by harmonized curves should give a satisfactory check against its basic data when tested as suggested by Bruce. The tentative standard set up by Bruce is that a volume table should measure its basic data within 1% of the actual volumes. Now suppose another table were constructed in which the procedure in handling the measurement of the trees varied slightly, causing a variation in volume from 5 to 10%. How could a test be applied to compare these two tables, or how could either table be satisfactorily tested for applicability to another set of material unless the volumes of the trees were arrived at in exactly the same fashion? How can a limit of error in testing cubic foot tables of 1% be met when differences 5 to 10 times this amount may be caused by the method of handling the tree measurement in the field and office? If we are to place cubic volume table work on a sound basis the procedure in regard to this point should be standardized.

The following material selected at random from spruce data will serve to illustrate the point:

Tree Number	1		2		3		4		5	
D. B. H.	5.2		7.		9.8		18.		17.2	
Total Height	45		42		57		76		75	
Volume No. 1	3.62	—3.5	6.57	—10.1	13.7	—5.0	56.15	—5.9	46.86	—7.6
Volume No. 2	3.47	—1.0	6.22	— 4.7	13.31	—2.0	55.72	—5.0	46.76	—7.3
Volume No. 3	3.31	—5.4	5.81	— 2.2	12.88	—1.5	54.75	—3.2	45.97	—5.6
Volume No. 4	3.50	—	5.95	—	13.07	—	53.04	—	43.59	—
Volume No. 5	3.25	—7.0	5.61	— 5.5	12.96	—0.9	55.4	—4.3	44.96	—3.3

Opposite each volume is given the percent variation from No. 4 taken as a base.

Trees 1, 2, and 3 were measured at intervals of 8.5′ above stump as cut and allow a stump of 1% of total height in calculation.

Trees 4 and 5 were measured at 10′ intervals from the ground and allow no stump.

Volume No. 1. Stump as cylinder from point of cut.
Section by Smalian formula in uniform lengths throughout.

Volume No. 2. Stump as cylinder from point of cut.
Stump to breast height and breast height to first section computed separately.

Volume No. 3. Portion below breast height figured at cylinder, disregarding actual stump measurement. Other sections by Smalian formula.

Volume No. 4. Stump as cylinder from point of cut in trees 1, 2, 3—no stump in trees 4 and 5.
Sections 1 and 2 combined and computed by Huber's formula. Other sections by Smalian formula

Volume No. 5. Total volume from breast high form factors based on $\frac{d}{D} = a + bl$ (Behre).

COMMENTS

1. The conventional system always gives an exaggerated result and should never be used without modification.

2. Splitting the butt section in two by figuring separately to the breast high point (2) reduces this error some, but still figures the butt as two convex sections when in reality the taper curve is concave.

3. Neglecting all root swell below breast height frees the work of variable factor due to varying height of measuring stump diameter and gives a volume more nearly that actually used. Most convenient when sections are measured at 1-10 intervals. When root swell extends above breast high error in applying Smalian formula to first section offsets the neglect of taper below breast height.

4. Makes butt section independent of either the stump or breast height measurement by using the diameter of first section as the middle diameter of a double length section calculated by Huber's formula. Entirely eliminates volume in butt swell, but subject to wide fluctuations because entire volume of two lower sections are based upon the single measurement of the diameter of first section. Does not require a separate calculation. Sections of uniform length can be figured by formula $V = (2a + \frac{b}{2} + c + d + ..\frac{n}{2})\ l.$

PROBLEMS AND METHODS IN FOREST ENTOMOLOGY

By Ivar Tragardh

One of the most important results gained by modern biological investigations is the realization of the intimate and close connection which exists between all the living organisms. The activities of every one of them influence the activities of many others and all the time we witness how reciprocal performances are displayed in different directions. Each is like a mesh in the large network woven on life's large loom, and is connected with all the other meshes. A little pull in one part of the texture is transmitted to the rest of it and is noticed all over it.

In the forest this mutability manifests itself no less than in any other place in nature. To some extent I do believe that most of the foresters realize this, for instance, in questions referring to the dependency of the growth of the trees on the processess which take place in the soil. But I have on the other hand the impression that more rarely it occurs to our foresters that the forest insects form an entirely normal and, so to speak, legitimate integrating part of the forest.

It is probably a certain apparent similarity between the outbreak of an epidemic and the periodical devastations caused by some insects which is at the bottom of this most common idea that the activities of forest insects are to be looked upon as plant diseases. It is due to this conception that the applied entomology in Germany, decidedly to its great harm, for a long time has been regarded as a mere adjunct to the plant pathology.

The Americans on the contrary keep these two branches of science sharply apart, although of course in close cooperation. Their refutation of the German theory was expressed right to the point by Dr. L. O. Howard, chief of the U. S. Bureau of Entomology, when he said at the Congress of Applied Entomology and Phytopathology held this summer at Waagoningen, Holland: "When a cow eats the grass, nobody would consider this activity of the cow as a grass disease."

The theory that the activities of the insects in the forests must be looked upon as a sort of disease, often tacitly connected with the conception that under normal conditions it is a question not worth considering—this very theory causes that, the forester pays too little

(Address given at the Nordisha entomologmotot, Stockholm, June 29-30, 1923)

attention to the forest insects in his daily work and to the entomological consequences which may result from some or other of his undertakings. At the same time truly it must be confessed that our knowledge in forest entomology in too many cases is unable to offer the information asked for by the practical man. Yet it hardly seems just to blame the forest entomology in our country (Sweden) for that, considering how young it is here as an institution, when at the same time it is commonly admitted in Germany where forest entomology is more than one century old, that it is first within the last decennials that the beginning has been made to cope with the descriptive and systematic work which necessarily must be done prior to the handling of the big economic problems.

However, it may just now be the proper time to present a review of some of the problems and methods of forest entomology as I see them after eight years of work with the government's forest experimental station. Of course, I am fully aware of how incomplete it will be and also that it possibly may bear out some wrong conceptions. But even so, I do believe that it may stimulate those which are interested in the subject to closer cooperation and, who knows, even encourage new men to enter into our work. The speaker has formerly pointed out, with all emphasis, how important it is always to consider the presence of the forest insects when forest problems are discussed, and thoroughly to deliberate the entomological consequences which may result from the appliance of the different methods by which the forest problems can be handled. This principle, however, can not be too strongly emphasized, and I shall, therefore, for its further support and mainly from my own experiences, add some more examples to elucidate it.

Three examples will first be given to show that forest insects are capable, to a certain extent, to adapt themselves to existing circumstances, involving that when an emergency is forced upon them they may even be able to change from one host to another. This is exactly what took place in the case reported by Sommerville in England, where, after a complete cutting down of a lot of pines close to a growth of larch, the logs were left over through the summer season without being stripped of the bark and these were attacked by *Myelophilus piniperda* in great number. But when the next generation of this bark beetle, which normally noes not attack larch, was unable to find any living pines to feed on, it turned to the larch trees, damaging their crowns to such an extent that all the trees died. This incident is the

more shocking as it was not the proprietor of the large grove who was responsible for the careless handling of the pine timber.

In a somewhat similar manner an isolated lot of larch at Vingsker, Sweden, was, in 1915, infested with *Ips typogrophus* which usually does not attack this tree. The bark beetles came from a pile of infested spruce logs placed near the grove. Several of the larch trees died. Also in this case carelessness was directly responsible for the damage done.

In the third case this was different, as nobody really could be blamed for what happened, and even an expert hardly could have predicted the outcome. Near Storebro, in Ostergötland, a six year old pine plantation, belonging to the "Forest Society" (Skogesällskapet) had been planted at a distance not far from a lot of spruces. In this latter lot *Dendroctonus micana* had evidently been present in a comparatively great number, but without anybody knowing about it. After the spruces had been cut down *Dendroctonus* was found to proceed to the pine culture. Here they made large galleries near the roots, completely encircling the trunk, and also formed holes for the depositing of their eggs. However, in this latter respect they did not succeed and no progeny issued, but the pines died from the injuries.

The influence of a certain forest method upon the behavior of forest insects was clearly demonstrated in a case of *Ips acuminatus.* This bark beetle is one of the most common species in the northern part of Sweden and an insect typical for areas in which logging operations of the pine forest has been conducted. As the species can develop in small branches there is always plenty of material in these localities for the depositing of eggs and therefore it very seldom attacks the standing trees. Under very extraordinary conditions, however, the species is able to cause some injuries; namely, when the trees from the original forest are cut after a lapse of from 12 to 15 years and the tops of these trees have been left lying among the young pines that have grown up after the clearing of the old wood. For then *Ips acuminatus* will be attracted in such great numbers that they can not find sufficient material for ovipositing and consequently they attack the young pines, causing their death (Fig. 3).

An average of ten young pines are in this way killed for each top lying on the ground, which approximately corresponds to 20% of all the pines.

In comparing forest entomology with agricultural entomology certain important differences reveal themselves right away, and among

these especially a fundamental distinction between the two categories of injurious insects, namely, the primary and secondary forest enemies. The primary enemies destroy the foliage and attack the living bark of the trees; the secondary belong in general to species which live under the dead bark above and below the ground or in the wood of the trees. They are mostly found in weakened trees, for the reason that these are not capable as are the various trees to react effectively against the attacks by help of the sap which, through the wounds, seeps into the gnaws and drowns the intruders. Even in a case where, for instance, a bark beetle succeeds in completing its brood galleries and depositing the eggs in their holes, the sap from the root may kill both the eggs and the young larvae.

Of course, the resistance of the trees depends not only upon the healthy condition, but also upon the number of the attacking insects and their destructive power. A low resistant power may be caused by insufficient foliage after the attacks of other insects, or be effected by the wind, the snow cover or forest fires.

As an example that shows how long a tree can withstand repeated attacks before it succumbs, the following observation may serve. It was made at the Grönainka Forest School, Gästrikland, in 1920. For at least fourteen years some birch trees had been exposed to the repeated attacks of *Scolytus ratzeburgi.* The beetles came from a nearby stock of birch firewood. For twelve years the attacks were overcome (in one case no less than 90 attacks), but gradually the trees were weakened, and in 1919 the beetles were successful in six different places. In 1920, 29 brood galleries were formed, from which a progeny undoubtedly would have developed.

Also, in other cases in which different species of bark beetles were involved, the brood galleries were found frustrated in a similar way, which proves that the trees often are able to defend themselves.

Sometimes, however, we find that the efforts have been less effective, and with a travesty of the old saying, "the operation was successful, but the patient died," we must admit that the operation did not succeed and the patient died all the same.

Now and then we find spruces full of unsuccessful brood galleries of *Myelophilus piniperda* and *M. minor* which easily can be recognized by the white resinous incrustations in their walls, with all the eggs drowned in the resin, and yet the trees were killed, for the insects had attacked the spruces in such great number that the trees had died from exhaustion.

The fact that so many of the injurious forest insect species are secondary is of great importance in combating them, as it is these very same species which also deposit and develop in the felled trees on the ground, in chopped branches, in stumps or roots; and as their presence and development often is influenced by man's conduct in the forest, this factor must therefore be greatly emphasized by the forest entomologist.

Another noticeable difference between the work of forest entomology and agricultural entomology is due to the size and longevity of trees. A forest entomologist is able to observe in detail not only the general reactions of trees of different ages and sizes, but also to study the cause and effect of the attack on the single trees, and by analysis of the trunks to follow the sequence in which the different insect species arrive and cooperate in the destruction of the trees.

The first analysis refers to a dead spruce from Kolleberga, June, 1923. Two species of weevils, *Pissodes pini* and *Pissodes piniphilus,* opened the attack in 1922, the *Pissodes pini* occupying the lower portion of the trunk up to the height of 30 cm. above the ground; the *P. piniphilus* the upper portion from 4.7 meters to 6.7 meters above the ground. The trees became so weakened from the attack of these two species that in the following year it was infested with both *Myelophilus piniperda* and *M. minor,* the former confined to the lower two meters of the tree and the latter found from 2.3 meters upwards.

Thus the analysis shows that in this particular case the *Pissodes* weevils are the primary insects and the *Myelophilus* form the secondary. Then, by inference, we can deduce that the work of extermination primarily must be directed against the two species of *Pissodes,* which at the same time, almost prevents the propagation of the two *Myelophilus* forms to diminish.

Another analysis refers to a dead pine from Glyjen (Fig. 7). In this case the *Peridermium,* probably in 1920, opened the attack and was followed in 1921 by *Pissodes piniphilus*: in the next year *Myelophilus piniperda* came in the top of the tree. In this analysis *Pissodes pini* was not found as in the former analysis.

The third pine analysis is from Gärna in Dalekarlien (Fig. 8). It does not give any information on the sequence in which the different species invaded, but it has, nevertheless, a special interest in that it shows, as far as I know, for the first time, that cooperation can take place between *Ips acuminatus* and the two species of *Myelophilus, M. piniperda* and *M. minor,* and also that Myelophilus minor can breed beneath a bark 3 cm. thick.

A further pine analysis tells us the circumstances under which a species, new to Sweden, *Carphoborus chodledkovskyi,* was found. The crown of the pine had been attacked by *Pissodes piniferus* in summer, 1921; in the spring, 1922, followed at the base of the tree *Myelophilus piniperda* and a few *Myelophilus minor* and first the next year, 1923, *Carphoborus chodledkovskyi* infested a part of the trunk which, till then, had been spared.

It is obvious that similar analyses contribute more to our biological knowledge of the species than the mere statement that this or that form has been "found in a dead and dried pine." They are, in fact, of the greatest value for obtaining an exact knowledge about the life history of bark beetles and other insects with similar habits. We must use every opportunity to bring such analyses together from the different parts of the country and at the same time try to bring together all available information about the conditions of the plots, their ages, density, the manner in which they are handled, etc., etc.

One of the general problems of applied entomology, and one common to all its branches, is the question about the genesis of insect devastations, how they rise and how they develop.

It is a general belief that man himself has been the first to cause injurious insects to be more commonly seen, for instance, when he began to cultivate certain plants, which means to grow a great amount of the same sort of a plant on a large area. Gradually when man brought in for utilization and control one wild plant after the other, the phytophagous insects which were feeding on these plants began simultaneously to make themselves felt as injurious forms. But these, in turn, were followed by the predators and parasites, whose opportunities for multiplying also grew in the same proportion on account of the increasing number of the hosts. Thus a certain balance was established in probably a rather short time.

Exactly the same sequence of events is displayed every time man, in some field or other, undertakes a new form of culture. In the tropics at the present day one can study how the clearing of the primitive forest and the subsequent cultivation of the cleared land influence the insect world.

Fickenday reports from Sumatra how in a newly established oil palm plantation the plants were overrun by earwigs, which attacked the fruits. Scorpions and centipedes became numerous and a small Colsophorid Larva began to be very injurious. When the plantation was six years old one started in with another method. Instead of keeping the

growth cleared around the palms one let the plants from the jungle enter freely and confined the efforts to cutting the vegetation only so far down that the crowns of the palms became free. It did not take long before the results appeared. The earwigs vanished for the greatest part probably driven away by a small ant which possibly is instrumental in the fertilization of the palms, and the Coleophorids disappeared simultaneously.

Very illustrative in the same respect is a case reported by the highly deserving, prematurely deceased Danish entomologist, Dr. I. C. Nielsen. He proved that a small, till then rare phytophagous hymenopteron increased immensely in number when one undertook to plant oak cultures in Seeland on a large scale.

Probably the *Lophyrus* devastations so commonly appearing in 1880-'90 in certain parts of Västergötland can be explained in the same way, as large pine cultures at that time were planted there and large areas for a while were covered with a relatively pure stand of pines of that age which is especially attractive to *Lophyrus*.

However, even if the presence of large, pure plots of trees of equal age must be considered as a condition of primary importance for the starting of the devastations, it is perfectly evident that other factors also must be involved. Thus it is generally believed that the periodical devastations caused by primary insects sometimes may be due to climatic factors. This is suggested by the fact that the devastations often are contemporaneous over large regions and that the only influencing factors possible to be detected are climatic. Well known examples of insects causing that kind of widely spread, contemporaneous ravages are: *Cheimatobia brumata, Cheimatobia boreata* and *Hibernia defoliaria,* which three species often appear at the same time, *Arxyresthia coniugella,* "havreblad lusen," *Eriocrania* with different species on birch, *Bupalus piniarius, Larentia nebulata* and others.

We know, however, at present very little about the influences of the climatic factors which can effect such extreme propagations. In fact, only in one case it has been clearly demonstrated, namely, for the North American aphid *Toxoptera graminum.*

Regarding this insect it was observed that its devastations occur with automatic regularity, when a cold spring followed an unusual mild fall and winter. Under normal conditions the propagation of the aphid stops in the fall with a male-female generation that produces over-wintering eggs. But when the temperature is abnormally high in said season the males do not appear and the propagation continues with one

parthenogenetic female generation after the other, with the result that aphids are forthcoming in the following spring in a number considerably beyond the normal. As an isolated phenomenon, however, this factor does not produce a real devastation if a normal spring follows the mild winter, for then a parasite hymenopteron which is the principal enemy of this aphid will soon check the initiated devastation; but experiments have shown that this hymenopteron demands a somewhat higher temperature to develop than the aphid and must have a warm spring for its rapid propagation. Consequently if a cold spring follows a warm winter it will prevent the hymenopteron but not the aphid from multiplying and then the devastation sets in.

Concerning the appearance of *Buralus Piniarius* in Sweden and Germany some facts exist which to a certain extent may offer a definite explanation of a connection between a climatic factor and the rise of its devastations. These latter are limited to the eastern part of South Sweden, viz., that part where the amount of the yearly rainfall is less than 550 mm. It also has become known that the outbreak of its devastations is preceded by a couple of years with a noticeably lessened downpour, for instance at Nyköping in 1912 about 700 mm; in 1913, 600 mm.; and 1914, 410 mm. We are also aware that the larvæ hibernating in the field are attacked by a parasitic fungus. *Verticillum corymbosum,* and we know that the growth of the parasitic fungi is favorably influenced by moisture. It is obvious that when this controlling factor is practically eliminated in the drier parts of Sweden after a couple of dry years—and we may add in certain poor moraine-fields—it has the effect that the number of *Bupalus* increases.

To study in detail the origin of the devastations of injurious insects is one of the most central problems of the applied entomology. But it demands costly experimental arrangements which as yet at least cannot be undertaken by our country. And, well, some of our entomologists will probably have to cross the ocean to study at close range the methods which with so much success have been developed in the United States.

The preliminary steps, however, must be done as soon as possible and certainly to accomplish these the Scandinavian countries could help each other. Already now the time has come to utilize the rich material aggregated for the last 40 years in our yearly reports to work out a series of tables in which the different periods of insect devastations are grouped together with certain climatic factors. Such tables ought to

at least give a hint about where the problems lie and how they should be tackled.

What now the question concerns as to how the primary injurious insects should be combated, it may first be emphasized that the methods applied by the forest and the agricultural entomology are essentially different. On account of the size of the forest areas and of the individual trees, the idea of using direct methods to exterminate the injurious insects is on the whole absolutely precluded. It is simply out of the question on account of the utter disproportion between the expenses involved and the real value of what could be saved. To follow this course would in most cases be entirely impractical.

Instead of that the forest entomologist must concentrate all his efforts to develop methods by which devastations can be prevented, and to that end should all the phases of the biology of the forest insects be scrutinized into the most minute details and all the factors connected with their activities and appearances should be carefully considered, be it the forest methods applied, or the nature of the ground, or the density of the growth, etc., etc.

In many cases we will find, I am sure, that these preventive measures must consist in giving more close consideration than heretofore done not only to a proper intermixture of different sorts of trees and of different year-classes of the same sort of trees, but also to a suitable composition of the entire forest flora. For the more various the vegetation is the richer is the fauna of phytophagous insects, and consequently also of the parasites and the predacious insects. To illustrate the indirect influence of the forest vegetation on the fauna of parasitic hymenoptera some of the results from the investigations of the nun (*Lymantria monacha*) devastations at Gualöv may serve. Here it was found that the parasitic hymenoptera preferably attack the pupae of the nun, an observation which already had been made by Simon Bengtsson. The most common of the parasites are the following *Pimpla* species: *P. arctica, P. instigator* and *P. examinator*. Part of them developed in the fall and part hibernated inside of the pupa shell of the nun and did not come out till the following year. But even these latter would have to wait for several months to deposit their eggs if the nun pupa was the only host available. All these *Pimpla* species, however, are distinctly polyphagous, as Bengtsson also has shown, and attack a score of different lepidopterous larvae. Therefore it is probable that the first generation develops in other Lepidoptera and that it is the second generation which attacks the nun pupae; consequently the possibility for the finding

of a host in the beginning of the summer is greatly dependent on the vegetation of the forest. The richer it is, the better are the chances that its lepidopterous fauna may contain species which can serve as hosts for the different *Pimpla* forms in the first part of the summer. The food plants of these Lepidoptera hosts belong to the genera *Salix, Populus, Rose, Plantago, Cynoglossum, Rumex,* and *Calluna* and the presence and activities of the *Pimpula* species in Gualöv are, therefore, indirectly dependent upon this vegetation. This is another example of how in nature one phenomonon enters into and influences another. If the vegetation is various the Lepidoptera fauna is rich, involving that the fauna of parasitic Hymenoptera also is rich which again means that many will be available as hosts for the first generation of the *Pimpla* species which in the second generation infest the pupae of the nun. In Gualöv the conditions were in that respect very unfavorable for the propagation of the *Pimpla* species.

All these observations and deductions have been mentioned in rather great detail because they have a bearing far beyond the single case in question to which here is referred. It can namely be taken for granted that the insect devastations in Germany which generally are now ascribed to the forestry methods formerly applied in that country and by which the original mixed growths were changed into pure forests with trees of the same ages, mainly were due to the therefrom resulting lack of a rich fauna of phytophagous insects entailing the presence of a rich fauna of predacious and parasitic insects.

Another example which demonstrates the indirect effect of the vegetation on the fauna of the parasites is offered by the remarkable behavior of *Cidaris dilutata* in the birch region of the high mountains of Scandinavia. This species is found in most parts of Europe but it is only in these Scandinavian localities that it periodically appears in great masses. An investigation of its parasites undertaken by the author showed that its principal enemies are *Rhotas circumecriptus* and *Itoplectus alternans,* both polyphagous and widely distributed.

With *Cidaris dilutata* as the only host present, as it presumably is in the Scandinavian mountains, the extraordinary phenomenon is thereby explained that this widely distributed Geometrid becomes a pest only in localities which climatically are the least opportune for its development. Its two parasites are polyphagous and therefore always fairly common in most places inside the range of their distribution, but necessarily very rare here where *Cidaria* is the only host present, and usually only limited in numbers. When now the moth incidentally due to favorable climatic

conditions suddenly becomes numerous, also in these localities it takes some time for the parasites to multiply sufficiently to catch up with it, while in the other parts of the range of their distribution where several hosts always are available the parasites are right from the beginning able to multiply sufficiently to stop the devastation when it starts.

In the investigations work dealing with the activities and behavior of forest insects the method of applying sample plots should be used to the greatest possible extent, modified to suit any special problem; and this method should be practiced not only at the time when the insect devastations occur but also under normal conditions when the forest insects are present in their ordinary limited number. On a small scale such sample plots were assigned for the study of some of the recent devastations in Sweden, and so far with promising results, as it has been possible for us to formulate an objective estimation of the size of the outbreaks. A few cases from the activities of the Division of Forest Insects may exemplify the methods of control plots. At Gualöv during the period from 1915 to 1917 an isolated, almost 50 years' old plot of pines was attacked by the nun. A pair of sample plots were established to study the influence of the attack on the pines. The outline of the trunks in the plot and their relative distance from each other as well as the outline of the crowns were measured exactly and a projection was made on a map with a scale applied, according to which the distances were given four times larger than the scale applied to the trees. On this map it is plainly seen that only a few (five) small trees with scrubby and poorly developed tops were destroyed by the attacks of *Myelophilus piniperda* out of a lot of 43 trees, and it is just that kind of trees which normally succumb to the attacks of this bark beetle also in the natural, not forested woods. This investigation confirmed the correctness of our previous opinion that the pine trees possess a high grade of resistance against the attacks of the nun, because there is no reason to believe that the death of the five trees in any way was connected with the ravages of this moth.

After devastations caused by the Geometrid *Bupalus piniarius* in Sprby kronopark the sample plot method was also applied to trace the sufferings which followed, and as a general result it seems as if the pine has much more difficulty in recovering from an attack of *Bupalus* than from one of the nun.

The sample plot method was also applied with good results in the investigation of a special behavior of a forest insect, the *Ips typographus*. In Sweden, namely, it is characteristic for this bark beetle to attack the

host tree by groups ranging from a pair to a few hundred pieces, while in Germany, judging from the German literature on the subject, nothing corresponding seems to take place. Here its ravages seem to increase from year to year, gradually spreading over larger areas. The best explanation to be suggested for this discrepancy was to assume that the beetle is subjected to a periodical wandering impulse corresponding to what is known to exist in the different North American *Dendroctonus* species; and to prove the correctness of this suggestion which I presented early in 1918 a sample plot was established 1921 in Hofors, where this bark beetle for years had made isolated attacks. The plot contained a group of spruces of which 19 had been attacked in 1919, 78 in 1920 and 22 in 1921. To designate the trees which had been attacked in the same year of 1921 in which the investigation began did not, of course, offer any difficulty; but to separate the trees which had died in 1920 from those which had died in 1919 appeared at first to be less easy. However, it was found that the bark beetle, *Hylurgons palliatus,* infected the untouched parts of all the trees which had been attacked the year before by *Ips.* with exception only of those which the *Ips.* had injured clear to the ground. Consequently when fresh attacks by *Hylurgons* are found in 1921 the particular spruce must have been killed in the preceding year, and thus it was possible to establish the above given record. In 1922 a revision was undertaken with the result that not one single spruce had been attacked that year in this locality. Thus it was definitely proven, at least in the present case, first that *Ips typographus* stays only three years in the same place and then migrates, and second that the number of trees attacked does not increase successively from year to year but that the peak is reached in the second year and then there is a decline. Some controlling factors with increasing activities must therefore be present. They were found in 1921 by the investigation of trunks from Hofors which had been attacked in 1920. In these a very high, about 90 percent of *Ips* larvae were either exterminated by predacious insects or infected by different kinds of hymenopterous parasites whose whitish, shining, fusiform larvae were adhering to shriveled bark beetle larvae or had spun their cocoons with the empty head capsules of the host larvae woven into the cocoon walls.

The impression was here strongly brought to one that the bark beetles would have been totally exterminated by their enemies if they had stayed there for one more year. But they did not. In 1922 the survivors migrated somewhere else. It therefore seems possible to

presume that with all the given facts taken into consideration that the migrating impulse has developed in *Ips typographus* as a protection against the—at least in Sweden—rather numerous horde of parasites and predatory insects which feed upon it. A constant game of hide and seek is thus played between the injurious insects and their enemies. The above given examples may suffice to demonstrate how necessary the appliance of sample plots is for the study of forest insects. To emphasize this may possibly be considered as superfluous here in Sweden where the method is known everywhere through the activities of our Forest Division, but to those forest entomologists who do not have the benefit of performing their work in connection with a forest experimental institution like ours—and they may be in the majority in Europe —the method may probably not be so familiar, and it is for their sake particularly that I have discussed the control plot method in considerable detail.

It is a matter of course that the behavior of the *secondary* insects, for instance the bark beetles, are influenced also by different climatic factors as are the primary insects. Directly thereby that the swarming period is advanced or retarded and the extent of the course of development is lengthened or shortened, which in some cases reacts on the number of the generations and consequently influences the figures indicating the amount of individuals produced. Indirectly by the additional number of brood trees which become available after heavy snowfalls and wind storms.

The influences of the climate at least upon our common bark beetles should therefore be studied, and it would be very desirable year after year, in different parts of the country and according to a common plan to have trap tree investigations made in connection with meterological observations.

As an example of an investigation of this character the following record may serve of the work which was done in the summer of 1918 at the Gammelkrappa Forest College. Strangely as it must appear, this record seems to be the first one published of the swarming periods of our more common bark beetles. On the plate Fig. 14, each dot indicates that at the date registered above the dot that particular species was observed to bore itself into the bark or to work on the surface of the trap trees which were laid out for this purpose.

It is evident that the table only can give a very approximate information on the entire course and it does not tell anything about the genetic connection of the individuals found at the different dates, but

it shows at what various periods the single species swarm. Further explanatory details, however, cannot be entered into here.

Besides these records referring to the seasonal history of the bark beetles and other important secondary forest insects, including statements of the length of the immature stages, many analyses should be made of dead trees, of trees in the sample plots as was pointed out above, and also of trap trees of different sorts. We will, moreover, have to consider the very important fact that many of these insects oviposit in the cut tree logs or in the stumps or the roots which have been left over from the clearing of the land, and are greatly dependent on man's activities in the wood.

The investigation must therefore be outlined so that it clearly determines the effects of the cutting time, of the exposure and the methods of storing, of the dimensions of the trees, the thickness of the bark and the extent to which the stripping has been performed.

Some of these points may be illustrated by the following study of the behavior of *Myelophilus piniperda.* A 30-year old pine wood at Rödjenäs, Smaland, had been gone over in the middle of February, the cut logs measuring an average length of 7.8 meters were left lying in the wood and in these *Myelophilus piniperda* was breeding. Now the first problem of interest to us was to find out how the attack commensurates with the different dimensions of the trees. The results obtained are shown by the curve on Figure 15. From this it can be seen that logs measuring less than 5 cm. in diameter breast-height are not attacked by the bark beetle; that pines with the diameter breast-height between 5 and 6.5 cm. are infested to a height from the root of 3 d.c.m.; and that those with an average diameter breast-height of 10.3 cm. are infested to a height of 1.4 meters. Hence it will suffice to strip these larger logs only 1.5 meters above the ground to protect them.

Another problem was to find out what particular relation existed between the dimensions of the cut trees and the prospective increases in number of *Myelophilus piniperda.*

The curve on Figure 15 is based on the results obtained from investigations at Rödjenäs, June 13th, of girdled pines (gallringsvirke) which were cut in October-November and cleaned of twigs and moved to an open storing place in December. It shows that while the number of the brood galleries on a 4 meter long stick with 13 cm. diameter breast-height is 10, it increases five times when the d.b.h. is 19 cm., which means that the number of galleries increases in faster progression than the tree grows in thickness. To express by definite figures the total in-

crease in number of individuals the lengths of the brood galleries were measured and the egg chambers of each gallery counted, the result obtained was that the average number of the egg chambers was 60 for a brood gallery of 9.5 cm. length, and this means that 3,000 eggs were deposited in each of the 4 meter long and 19 cm. d.b.h. sticks. Of course this figure does not express the real accession figure of the *Myelophilus piniperda;* it only shows what the propagation would have been if parasites and predacious insects had not interfered. Fortunately these enemies are present in great numbers and the figure giving the real accession of this spreading factor, as Seitner has termed it, is considerably lower. To investigate this factor which ought to vary with the different years during a period of ravaging, the enemies of our most common forest insects should be thoroughly studied.

On table 19 is demonstrated the influence which the cutting dates and the exposure to the sun of the cut trees has on the composition of the bark beetle fauna, and it is clearly borne out that the bark beetles belong to three different groups which may be characterized as follows:

(1) Relative primary species—*Myelophilus piniperda. Ips proximus* and *I. quadridens.*

(2) Secondary species—*Hylurgons palliatus* and *Xyleterus lineatus.*

(3) Tertiary species—*Ips laricia.*

The table also shows that the different species have adapted themselves to different host trees, evidently to avoid competition.

Above I have tried to formulate some of the problems and methods of the forest entomology as I see them; unnecessary to express that no completeness whatsoever has been intended.

PROBLEMS AND METHODS IN FOREST ENTOMOLOGY

By F. C. Craighead

Remarks on Dr. Tragardh's Paper

A few days ago Dr. Boving gave me a copy of Dr. Tragardh's paper "Problems and Methods in Forest Entomology," which he was good enough to translate from the Swedish and thus make it more readily available to American entomologists. What impressed me most in reading this paper was the striking similarity in objectives and methods of investigation in Sweden and America. Further similarity is indicated in the examples used to illustrate the more general statements; one might substitute names of native insects for the European species and in many cases the discussion would be wholly applicable here. There are, however, certain striking dissimilarities, particularly in the character of problems assuming importance in our respective countries. This is suggested by the examples which Dr. Tragardh cites and is probably due to the greater proportion of mature timber in this country and to the fact that forestry in Sweden has progressed to a more intensive stage than here. At present we are most concerned with a few insects of major importance (those causing widespread devastation), while many of the less spectacular insects, though in the aggregate probably nearly as destructive, are as yet receiving little attention, for little in the way of control or prevention can be applied under present economic conditions.

The Germans are now realizing, as evidenced in their own publications and commented on by Tragardh, that in an effort to grow new timber crops with the greatest possible financial returns they have overlooked the interrelation of the biotic factors in the forest association. They failed to consider forest entomology as a part of silviculture, considering it as a side issue with plant pathology, and insects and fungi as an existing menace which must be tolerated. The rapid development of forest entomology in Sweden in recent years is no doubt in a large measure due to the abandonment of this idea and the consideration of forest entomology on an equal footing with the other sciences of forestry. Although something of the same tolerance of forest insect losses exists in this country (we particularly meet it in our efforts to carry new ideas to the lumberman), yet we are far more fortunate when it comes

to the attitude of the foresters themselves. In fact, in recent years, with the development of the Forest Service Experiment Stations, the men engaged in research realize that forest entomology and also forest pathology must be considered as a part of their silvicultural problems. Consequently we are far from being able to meet the demands for carrying out our part of these investigations.

Tragardh has dealt with what might be called a newer phase of forest entomology in a very lucid and comprehensive manner. It might be termed the ecological aspect of forest entomology and as such applied to practical forestry. This conception, fostered by Dr. A. D. Hopkins, has developed rapidly in recent years. I was very much pleased to find through my contact last summer with Dr. J. W. Munre, Entomologist of the British Forestry Commission, that he is working towards the same objective. The trend of investigations in this country shows that it is gradually superseding the necessary preliminary taxonomic and life history studies which serve as a foundation. Although I hope to comment more at length on this subject at a later date, it may be opportune to briefly elaborate at this time.

We cannot hope to get very far in the control of forest insects, that is true forest pests, by direct control methods, but we must more and more rely on measures which will produce unfavorable environments for the multiplication of the insects. At present we are using direct methods against bark beetles in the mature forests of the West and South, yet we know these methods are expensive and results are variable. Recent studies by Mr. Miller and his associates, though at present very incomplete, are nevertheless very suggestive. We are finding that these beetles are not so indiscriminate in their attack nor these outbreaks so haphazard as at first appeared. Evidence is accumulating indicating that the condition of the tree is of prime importance for the necessary increase in numbers. It is true, as Tragardh points out, they can adapt themselves to very adverse conditions but under such conditions never assume epidemic proportions. It is found that felled trees, trap trees girdled or cut at various seasons, the age of the tree, the site, the elevation, the forest type in which it is growing, and its rate of growth all have certain effects on the susceptibility of the material to attack of these primary beetles, as well as on the development of the subsequent broods. There is much to suggest that drought periods play an important part in bringing about a lower resistance on the part of the tree and a consequent higher percentage of development in the broods of the attacking beetles.

Similar interrelations can be pointed out in another class of insects of major importance—the defoliators. It is now known, at least in the case of the spruce budworm, that the composition of the forest plays an important part in the development of outbreaks. Certain favored species of trees or several species associated so as to produce favorable feeding requirements are necessary for the proper development of the larvae. It has further been shown that the mortality resulting from a given amount of defoliation is directly correlated with the previous vigor of the trees. Fungi and secondary insects, the composition of the forest, and site on which the trees are growing must as well be taken into consideration to obtain a true picture of the situation.

You may naturally ask—where is the practical application of all this? The chief objective of the forester is to grow future timber crops—to cut present stands so as to insure a future growing stock. His first consideration in doing this is to promote the reproduction of such species as will yield quickest returns of the most desirable timber. He may leave seed trees or use any one of several silvicultural systems in accomplishing this end. The selection of the methods will depend on the accumulated knowledge of all biotic factors in the forest and here is where the part of the entomologist comes in. It is necessary for the forest entomologist to determine what conditions in each particular case will be least favorable to insect epidemics that might cause disaster. The entomological considerations may only require maintaining rapid growth, a certain density of shade, certain species mixtures, or the selection of seed trees of special vigor. The insects are only one of the factors in a very complex whole and because of the many other considerations it is so essential, as Tragardh has pointed out, that the specialists in all these related sciences must cooperate to arrive at the correct solution of the forester's problems.

April 2, 1924.

FURTHER NOTE ON THE POSITION OF THE TORI IN BORDERED PITS IN RELATION TO PENETRATION OF PRESERVATIVES

By Gertrude J. Griffin

Assistant Xylotomist U. S. Forest Service, Forest Products Laboratory, Madison, Wis.

In a previous study[1] of the penetration of preservatives in Douglas fir wood, it was found that when the absorption and penetration of preservatives were rated as good the majority of tori[2] in the pits of summerwood tracheids were in the central or unaspirated position in the pit cavity; and that when the penetration was poor, the majority of tori in summerwood tracheids were aspirated or pushed to one side against the orifice of the pit cavity, completely closing it.

In the present study three heartwood specimens of western larch were taken from treated tie material of the Northern Pacific Ry., Paradise, Mont.; two heartwood specimens of larch and one of Douglas fir heartwood from treated tie material of the Great Northern Ry., Somers, Mont.; and one specimen of Douglas fir heartwood and one of lodgepole pine heartwood from treated tie material of the C. B. & Q. Ry., Sheridan, Wyo. These were examined to ascertain the position of the tori of the bordered pits.

The results of the study are shown in the accompanying table, and are in agreement with those previously noted. In the first four and last three of the eight specimens listed the penetration was poor and the majority of the tori in the summerwood were aspirated. The fifth specimen took the treatment easily, and in this case all but one of the twenty summerwood tori observed were in the central or unaspirated position.

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[1]Griffin, Gertrude J. "Bordered Pits in Douglas Fir: A study of the position of the torus in mountain and lowland specimens in relation to creosote penetration." Journal of Forestry, Nov., 1919.

[2]Tori are the microscopic valve-like structures in the bordered pits. The latter are thin portions overhung by a border in the cell walls of tracheids.

TABLE I.

Position of tori in relation to penetration of preservatives. Description of material, method and results of treatment applied, and location of tori.

Source of material	Description of specimen	Treatment: Preliminary	Treatment: Pressure period	Treatment: Final vacuum	Treatment: Kind of solution used	Treatment: Total time of treatment	Results of treatment: Absorption	Results of treatment: Depth of penetration	Location of tori: Springwood: Aspirated	Location of tori: Springwood: Central	Location of tori: Summerwood: Aspirated	Location of tori: Summerwood: Central
Near Flathead, Lake, Mont. N. P. Ry.	Larch tie, seasoned at least 1 year before treatment	Heated in oil at 230° F. for 2¾ hours	16¼ hours at 150 pounds per square inch	19 inches for 1 hour	50 per cent creosote and 50 per cent petroleum	20 hours	5.2 to 6.8 pounds per cubic foot	$\frac{1}{16}$ to ½ inch	20	0	18	2
Near Flathead Lake, Mont. N. P. Ry.	Larch tie, seasoned at least 1 year before treatment	Heated in oil at 230° F. for 2¾ hours	16¼ hours at 150 pounds per square inch	19 inches for 1 hour	50 per cent creosote and 50 per cent petroleum	20 hours	5.2 to 6.8 pounds per cubic foot	$\frac{1}{16}$ to ½ inch	20	0	18	2
Near Flathead Lake, Mont. N. P. Ry.	Larch tie, seasoned at least 1 year before treatment	Heated in oil at 230° F. for 2¾ hours	16¼ hours at 150 pounds per square inch	19 inches for 1 hour	50 per cent creosote and 50 per cent petroleum	20 hours	5.2 to 6.8 pounds per cubic foot	$\frac{1}{16}$ to ½ inch	20	0	17	3
Near Flathead Lake, Mont.; G. N. Ry.	Larch tie, seasoned 4 to 5 months in yard	Vacuum of about 19 inches drawn for 20 or 30 minutes	16¼ hours at 150 pounds per square inch	19 inches for 1 hour	50 per cent creosote and 50 per cent petroleum	20 hours	....	$\frac{1}{16}$ to ½ inch	20	0	18	2
Near Flathead Lake, Mont.; G. N. Ry.	Larch tie, séasoned 4 to 5 months in yard	Vacuum of about 19 inches drawn for 20 or 30 minutes	16¼ hours at 150 pounds per square inch	19 inches for 1 hour	50 per cent creosote and 50 per cent petroleum	20 hours	Good	Very good. Treated easily.	20	0	1	19
Near Flathead Lake, Mont.; G. N. Ry.	Douglas fir tie, triangular; seasoned 4 to 5 months in yard	Vacuum of about 19 inches drawn for 20 or 30 minutes	100 pounds per square inch for 12 hours. Solution at 200° F	Short final vacuum	4 per cent zinc chloride	About 13 hours	....	Very slight	20	0	20	0
Oregon or Washington; C. B. & Q.Ry.	Douglas fir tie; open piled, seasoned at least 1 year in yard	Steamed 1 hour at 20 pounds pressure. Vacuum of 19 ins. in ¾ hour. Total, 1 hour	175 pounds per square inch for 7 to 8 hours. Solution at 175° to 180° F.	½ hour	3 per cent zinc chloride	11 hours	½ pound per cubic foot	$\frac{1}{16}$ to ½ inch	20	0	20	0
Near Laramie, Wyo.; C. B. & Q.Ry.	Lodgepole pine tie; open piled, seasoned 10 to 12 months in yard	Steamed 1 hour at 20 pounds pressure. Vacuum of 19 ins. in ¾ hour. Total, 1 hour	175 pounds per square inch for 7 to 8 hours. Solution at 175° to 180° F.	½ hour	3 per cent zinc chloride	11 hours	½ pound per cubic foot	¼ to ½ inch	20	0	15	5

WHAT INTEREST TO USE IN FORESTRY

Majority Report of the Committee on Interest

The committee appointed at the last annual meeting to study this subject was given no instructions defining the scope of the study. It was evident at the outset that the subject might be treated under two headings:

1. Interest to be used in computing damage by forest fires.
2. Interest to be used in computing the probable profit in timber raising.

Properly speaking *interest* from the standpoint of forest management is the price that any particular forest owner has to pay for the use of capital if he is a borrower, or that he can secure for the use of capital if he is in a position to be a lender. The interest rate used in forestry must, therefore, vary absolutely in accordance with the situation of each individual owner.

In seeking investment capital is naturally interested in safety and profit. The greater the risk involved in an undertaking, the higher will be the rate of interest demanded. The rate of interest required on a forest investment in this country would naturally be considerably higher than on a similar investment in Europe before the war, first because of the higher risk, and second because of the greater opportunity for profitable investments in this country.

Quite apart from this question of the price of money is the *earnings* of a forest. By *earnings* is meant the net return which the individual owner can get on his particular forest investment. If the forest has cost the owner a certain amount, he can compare the earnings with the interest he has to pay on borrowed capital, or could receive if he loans capital, by dividing the net return by the capital. This will show him whether the forest investment he has actually made is paying him as much as the interest rate he has to pay, or can lend at.

It follows that just as the interest rate is entirely an individual matter to the forest owner depending on his financial and economical situation, so the earnings are an individual matter to the forest property as modified, however, by the methods of management applied by the owners.

It is evident that no committee can pass on the rate of interest which a forest owner should pay for the use of money or receive for the use of his capital.

The function of this committee as we see it is to formulate principles underlying the estimating of damage by fire since this whole subject was brought up at the last meeting in connection with the subject of fire damage.

The money damage to the owner of a burned forest depends upon the earnings of the particular forest before and after the fire. It has no relation to the rate of interest paid on borrowed capital. The purpose of adopting a rate is always to arrive at a value for immature timber as a basis for damages. Hence the owners' financial position with respect first to his investment, second to his returns, must be the basis of compensation and of appraisal. No rate will give this correctly except the rate earned. Any other rate distorts the results causing great differences between discounted values on one hand and cost plus interest on the other. It causes the investor to receive either more than he is earning on his investment or less than he is earning.

We are not trying to appraise the market value of immature timber, but the personal value to the owner. An investment of $100 may increase during a period of 20 years at the rate of 10 per cent. If the value is computed for an intermediate date by allowing only 4 per cent on the investment the resulting figure will be much less than the real value. On the other hand if the final value of $672.76 is discounted at 4 per cent the resulting figure will be much more than the real value.

If the value is to be computed upon the original investment, it is impossible to determine the interest which such investment is earning without predicting the final value after a definite term of years. In the same way if it is to be computed by discounting the final value, the rate can only be determined by comparing the predicted value with the original value. To arrive at the rate of interest in any case, it will be necessary to first ascertain the investment and second the probable future value. This necessitates the use of some kind of yield table. But one possible rate of interest can be arrived at if there is agreement upon the initial cost, the value of the final crop and the length of time required to produce it.

The committee has agreed upon the following principles and suggests their adoption by the Society:

1. That the damage to an immature forest cannot be based upon the market value of similar unburned immature forests, but must be determined by taking into consideration the cost of investment and the probable value at maturity.

2. That the same rate of interest should be used in figuring ahead on the cost of establishing a forest as in figuring backward on the expectation value.

3. Since earnings of a forest vary with the individual property as affected by soil, markets, rotation and other factors, there is no uniformity under American practice and it is, therefore, impracticable for the Society to adopt a uniform rate of interest for the whole country or even for one region.

4. That the rate of earnings of a forest varies according to the productivity of the forest and can only be determined by comparing the predicted value at the end of the rotation with the original investment. The resulting rate of interest will give the same values at any intermediate period whether applied to the investment or as a discount on the final value.

Austin F. Hawes
Donald Bruce
H. H. Chapman
T. W. Dwight
C. H. Guise
Burt P. Kirkland
David G. Mason

Minority Report of the Committee on Interest

The minority feels that the Society has a right to expect from the commitee not only the platitudes of the first paragraphs of the majority report but some items of information or opinion, and he therefore, with all humility, submits the following items of information or misinformation from his own slender store, that the members may have something definite to shoot at and with the hope of starting some intelligent discussion.

The most common rule of thumb rate of interest that the minority is familiar with is used frequently by business men in comparing the advisability of purchasing one or another of several tracts of land which are offered them by assuming that any investment which they may make in land will double every ten years through the operation of compound interest.

It may be that the chaotic economic conditions surrounding forestry in this country prevent foresters from seeing things as they really are, but most foresters seem to think that forestry is a splendid investment for some mythical individual who is willing to accept four per cent compound interest on his money and (in the case of a plantation, for example) let it ride for maybe fifty years without being able to touch either principal or interest. With their own money they seldom buy any

forest lands or lands suitable for planting. If they do buy land they do not often plant it with trees. Instead they buy bonds yielding semi-annual interest of six per cent or more and readily salable on short notice.

Why not face the facts?

There are too many profitable opportunities for even the small investor to invest his money at better than six per cent in relatively safe readily marketable securities in this country for them to be willing to tie up their money indefinitely in say a forest plantation as an independent investment standing on its own merits.

The majority report states: "The rate of interest required on a forest investment in this country would naturally be considerably higher than on a similar investment in Europe before the war, first because of the higher risk, and second because of the greater opportunity for profitable investment in this country." To the minority this presentation of the facts seems like putting the cart before the horse. The risk of depreciation of principal in a forest loan as the result of the above mentioned war, though it may have been under-estimated by Europeans, was, as events proved, in many cases a very real one. The real difference between their conditions and ours lies in the greater competition for capital here than in pre-war Europe. It seems to the minority that the Society has a right to expect an expression of opinion from the committee as to the measure of this difference. The minority therefore ventures the opinion that three and one-half per cent interest in pre-war Europe was as attractive to timberland owners as seven per cent is to us.

Before the war the minority was discussing with a large industrial concern the practicability of their providing themselves with a perpetual supply of a certain kind of wood. When asked what rate of interest they expected their own money to earn if employed in such a venture they replied nine per cent per annum. At that time they could probably have borrowed about sixty per cent of the necessary purchase price of timberland at five to six per cent, but the increased cost of logging, slash disposal or other items necessary to perpetuate their supply would have to come entirely from their own sources of capital. These items, though properly chargeable to capital account, would add little to the sale value of the land and could not be borrowed against.

About a year ago one of the highest grade financial papers contained on the same page a discussion of "The Cream of Public Utility Bonds," yielding less than five and one-quarter per cent, and a discussion of "The Rubber Problem." The latter quotes as reasonable rate of interest allowable on cash outlay during the period which elapses before any

profit can be taken out of the business as fifteen per cent per annum. This interest would be compounded for six years. While for that business "it was determined that an average of less than 15 per cent would not prove attractive to the public"—nevertheless, for purposes of comparison, the costs were also figured at 10 per cent. Compare that with the rate of 4 per cent sometimes assumed by foresters and the period of fifty years they expect their mythical investor to go without any return.

Fire Damage:

The minority most emphatically does not concur in the statement of the majority report that: "The money damage to the owner of a burned forest depends upon the earnings of the particular forest before and after the fire."

The minority understands that the courts have pretty consistently held to one rule of damages and though he cannot quote from the record, as he recalls it, this rule of damages from forest fire is about as follows: The measure of damage is the market value of the property as a whole before the fire less the market value of the property as a whole after the fire and less any salvage that it is possible to secure by the exercise of due diligence.

Therefore to the minority the majority discussion following the above quotation about earnings appears irrelevant and academic.

The minority does not agree to the principles suggested by the majority for adoption by the Society as follows:

"1. That the damage to an immature forest cannot be based upon the market value of similar unburned immature forests, but must be determined by taking into consideration the cost of investment and the probable value at maturity."

The minority does agree with numbers two and three.

The minority does not agree with number four:

"4. That the rate of earnings of a forest varies according to the productivity of the forest and can only be determined by comparing the predicted value at the end of the rotation with the original investment. The resulting rate of interest will give the same values at any intermediate period whether applied to the investment or as a discount on the final value."

The minority view is that the rate of earnings of a forest varies as much with the variations in costs and in market value of the product from year to year as it does according to the productivity of the forest. All predictions of this nature are subject to wide limits of error and can seldom be made "to stick" in court.

Signed, Edward S. Bryant,
Minority.

PROFESSIONAL ETHICS FOR FORESTERS

Report of the Committee

President, Society of American Foresters,
Dear Sir:

The committee on professional ethics appointed by your predecessor was unable to report during his term of office. We are now glad to submit our views to you, for consideration and such action as you think advisable.

We believe that in general the professional ethics of the foresters of the United States are on a high plane, comparing favorably with the standards maintained by other professions. This is due largely to the character of leadership we have enjoyed and to the rather exceptional class of men entering the profession. On the other hand perhaps there are individual cases at present which call for investigation and action, cases in which the conduct of foresters is at least open to question; and as time goes on there may be other such cases. It seems well, therefore, to discuss certain leading principles of conduct with a view to future guidance.

Briefly stated, our opinions are these:

1. We are not inclined to recommend the adoption of a written code of ethics at present, nor are we sure that a written code would ever be advisable. To draw the line between right and wrong conduct in the oldest professions, where precedent has been established by action on many cases, is a hard task. To draw such a line in a new profession—new to our field of work—would be still harder, for we lack precedent altogether.

Some of the professional societies have written codes, many are without them; and we are not convinced that those with written codes maintain a higher standard of ethics than those without. Whatever

advantages a written code may possess—and it has certain advantages, if lived up to—we do not believe it to be of prime importance. Ethical standards in any profession depend upon the spirit which exists among its members, and this spirit is vastly more important than any written code ever devised.

We think that the best way to foster and maintain a spirit in favor of clean professional conduct is to discuss and act upon individual cases in which conduct is clearly open to question; and we believe that such discussions should be frequent, wholly above-board, and followed by decisive action. In this way we might keep the question of ethics before us and gradually create among ourselves that spirit of professional conduct which is indispensable to work of a high standard.

The proposals relating to ethical conduct which follow, therefore, are submitted not as hard and fast rules, but as questions which, to our minds, are of sufficient importance to justify investigation whenever individual cases involving them are apparent. We suggest that they be put to the test whenever evidence warrants. Paragraph 2, needless to say, requires no discussion, for it lies beyond the field of argument.

2. As a matter of course a forester, like any other professional or business man, should be honest in his work. Dishonesty in any form should be followed promptly by expulsion from the Society.

3. A forester should not only believe in and cling to the principles of his profession, but also practice them so far as he is able. The fact that given economic conditions or the views of his employer will not permit him to practice this or that principle of forestry at any given time or place is not a good reason why he should disown those principles. He should continue to believe in and advocate them, with the aim of putting them into practice when economic conditions or the views of his employer change. More important still, he should work to change such economic conditions as are open to change through individual or collective effort, and to change his employer's opposition.

4. A forester should believe that forests are a public necessity, whether publicly or privately owned, and act on that belief. He should work against the devastation of forest growth, whether on public or private lands, and for such laws or changes in economic conditions as will obviate or mitigate devastation.

5. For a forester to express himself publicly in a manner to influence public opinion against what other foresters believe to be reasonable forest measures, is conduct distinctly open to question, unless he

clearly shows that his opposition is for the purpose of advancing the cause of forestry in other ways equally reasonable.

6. When a forester in private employ becomes the paid mouthpiece of private industry opposing, delaying, misrepresenting or distorting proposals for progress in forestry, he lays himself open at once to charges of unprofessional conduct.

7. A forester in private employ should, of course, be loyal to his employer, but not at the expense of the principles of his profession.

8. A forester should not profit financially from transactions inconsistent with his work as a forester. For example, his compensation should be by salary or stated fees, not in the form of commissions or trade discounts.

The constitution of the Society provides that charges of unprofessional conduct shall be made to that member of the Executive Council designated "In Charge of Admissions," and that he shall report his findings, with evidence, to the Council for final action. This places a heavy burden upon one man. We suggest that a Committee on Professional Ethics might consider charges and report, with recommendations, to that member of the Council, such a committee to be appointed from year to year by the President.

Very sincerely yours,

F. E. Olmsted, *Chairman.*
John F. Preston
R. T. Fisher
W. G. Howard
Theodore S. Woolsey, Jr.

In signing the above, I wish to be recorded as not approving Paragraph 7 on account of its ambiguity, and because I believe it is superfluous. I also decline to approve the last sentence of Paragraph 8, for I do not consider that because there may have been cases where individuals were guilty of improper conduct in connection with compensation in the forms mentioned it should be determined that such forms of compensation are necessarily wrong.

W. G. Howard

While our "leading principles" are obvious and subject to improved wording, I believe it is a step forward to attempt to define what is improper conduct.

Theodore S. Woolsey, Jr.

NATIONAL CONFERENCE ON OUTDOOR RECREATION

Report of the Committee on Resolutions

I.—CITIZENSHIP VALUES

1. That outdoor recreation furnishes opportunity to gain abounding health, strength, wholesome enjoyment, understanding and love of nature, good fellowship and keen sportsmanship and, above all, has a direct beneficial influence on the formation of sturdy character by developing those qualities of self-control, endurance under hardship, reliance on self, and cooperation with others in team work, which are so necessary to good citizenship.

II.—FEDERAL LAND POLICY

WHEREAS, it seems desirable to express the opinion of the Conference regarding the primary function of the two major governmental agencies naturally touching the field of recreation, namely, the National Park Service and the National Forest Service, be it

1. RESOLVED, That the Conference express its approval of the historic and popular belief that the National Parks system consists of permanent national reservations protecting inviolate those wonderful or unique areas of our country which are museums representing the scenery and principal natural features of the United States available in our great heritage of animate and inanimate nature.

2. That these Parks must be protected completely from all economic use; that their scenic qualities should represent features of national importance as distinguished from those of sectional or local significance, and that they must be preserved in a condition of unmodified nature.

3. That laws should be provided which will furnish an administration as nearly uniform as possible throughout the National Park system.

4. That the Conference express its approval of the statement that National Forests are areas set aside to protect and maintain in a permanently productive or useful condition lands unsuited to agriculture but capable of yielding timber or other general public benefits; and that all resources of National Forests, including recreation, should be developed to the greatest possible extent consistent with permanent productivity in such a way as to insure the highest use of all parts of

the area involved.

5. That the Conference respectfully calls to the attention of the President's Conference the fact that recreation in the National Forests may be better served by such adjustment of both state and federal laws and of responsibility for their execution that the Forest Service can administer effectively the wild life of the forests, and protect isolated gems of scenery such as may naturally fall within the forests.

AND WHEREAS, in the judgment of this Conference valuable recreational resources in the public domain are rapidly being lost to public use: Therefore be it

6. RESOLVED, That the attention of the Federal Government be called to need for a careful survey of all available resources of the publicly owned lands in order that we may secure adequate information regarding recreational facilities of such areas.

7. That the Federal Government be requested to give consideration to the administration of such areas of publicly owned lands as are found to have special importance by reason of their availability for recreational purposes.

8. That the President's Conference respectfully call to the attention of the Federal Government the fact that in determining the administration of recreational areas on publicly owned lands it is desirable to recognize the possibility of transfer of such lands to National Park Service, Forest Service, or to the States concerned, provided the specific areas fit themselves properly to use of these agencies.

9. That the Conference recognize the desirability of setting up a continuing body, perhaps of the Commission form, centered as now in the President's Cabinet, and having as its function the investigation of problems of Federal land policy so far as they relate to recreation, and the consideration of measures to secure in practice that continuity and harmony of policy in the administration of Federal lands for recreational purposes which is the desire of all the interests concerned.

III.—STATE PARKS AND FORESTS

1. We urge upon our governments, local, county, state and national, the acquisition of land and water areas suitable for recreation, and preservation of wild life, as a form of the conservation of our natural resources, until eventually there shall be public parks, forests, and preserves within easy access of all the people of our Nation, and also to encourage the interest of non-governmental agencies and individuals in

acquiring, maintaining and dedicating for public use similar areas.

2. The enactment of legislation, including adequate appropriations, and the adoption of policies which will insure cooperation between the Federal Government and the States and will promote the practice of forestry in its broadest sense and make the growing of timber by the private land owners safe and profitable.

IV.—SURVEY AND CLASSIFICATION OF RECREATION RESOURCES

1. That there should be a complete and comprehensive survey and classification of all recreational facilities and resources, both public and private, for the entire country.

2. That in the development of public reservations of recreational importance adequate systems of roads and trails connecting these reservations be provided.

V.—PLANTS AND FLOWERS

1. That we recognize that the education of school children and popular education through the press and other publications, and through churches, colleges, and in other ways, offer the surest means of protecting wild plants and flowers; and we heartily commend the work of the volunteer organizations which have already exerted much influence and proved the effectiveness of popular education.

2. That every city and town should possess, as part of the nature study equipment of the public schools, and for public recreation, a wild park in which the native vegetation is absolutely protected.

3. That laws to uphold private owners in the protection of such plants as dogwood, mountain-laurel, holly and other valuable native vegetation should be enacted by all the States.

4. That we recognize the great need of a National Arboretum and Botanical Park and we urge that in this institution, when established, special consideration be given to the protection of our native plants and to the development of an adequate knowledge of their care and propagation for purposes of public education and recreation.

VI.—BIRDS

1. That the greatest problem in connection with wild bird conservation today is the provision of an effective system of education on a scale greater than any hitherto attempted and the enlisting of the

assistance of all available agencies, including the press, the screen, and the radio.

2. That the principal practical problems of the immediate future are better endorsement of existing laws, strengthening the statutes in certain states and constant watchfulness against loss of ground already won.

3. That the importance should be emphasized in the administration of bird laws of basic surveys and inventories.

VII.—GAME AND FUR BEARING ANIMALS

1. That effort should be continued for the preservation of game animals through propagation, refuges, public shooting grounds, prevention of destructive practices, non-sale regulations, bag limits, licensing systems, special funds and other methods.

2. That special emphasis should be laid upon improvement and development of methods through non-political state game commissions with trained personnel, long tenure of service and broad administrative power; through conservation and reclamation of natural breeding or feeding grounds; through statistical surveys; and through efforts to obtain greater cooperation between state and private organizations interested in game.

3. That campaigns of extermination against predatory animals should be discouraged, except as authorized by experts under State or Federal control.

WHEREAS, the efficient administration of wild life depends upon a detailed and accurate knowledge of the animals concerned:

4. RESOLVED, That all sportsmen should cooperate with museums or other scientific institutions and so far as possible, make the results of their hunting available for study, research and permanent record.

WHEREAS, the decrease of hunting grounds, the rapid increase of hunters, liberal killing privileges and other destructive influences are now operating to diminish and exterminate game birds, animals and fishes.

5. RESOLVED, That steps should be taken promptly to secure reductions in bag limits and open seasons, which will reduce the annual volume of game killing, both migratory and non-migratory, by large amounts where necessary.

6. That the wild life on unreserved public lands should be administered where possible by the Federal Biological Survey.

VIII.—FISH

WHEREAS, Fisheries and aquatic resources are of very great importance as a source of food supply and as a means of providing health-giving recreation to all classes of citizenry; and

WHEREAS, these aquatic resources have been dangerously depleted and are further threatened by stream pollution;

THEREFORE, BE IT RESOLVED:

1. That scientific investigation, furnishing a sound basis for the administration of all fishery resources, be further encouraged by Federal, State and private agencies.
2. That propagation, stocking and rescue operations in public and private waters be greatly encouraged and enlarged.
3. That legislation is urgently needed, especially with respect to the uniformity of State laws, boundary waters, and anadronous fishes, such as salmon, striped bass, shad and sturgeon.
4. That Federal legislation should be secured stopping the interstate sale and shipment of black bass.
5. That recognition should be taken of the fact that Federal and State appropriations for fisheries work have not kept pace with the growing needs of the country.

IX.—POLLUTION AND DRAINAGE

WHEREAS, increasing industrial expansion results in the exceedingly dangerous and destructive pollution of rivers and coastal waters, thereby rendering them uninhabitable to aquatic life of all useful kinds, seriously impairing shore bathing, and materially restricting possibilities for recreation through the accumulation of oily wastes; and

WHEREAS, the menace from fire hazard, from floating oily wastes extends beyond the control of the Nation and involves also the high seas; be it

RESOLVED: That solution of the problem must be sought first, by educating public opinion to bring about cooperation of all corrective influences; second, by securing detailed information concerning the extent, sources and nature of pollution; third, by encouraging technical investigation of exact conditions and means for transforming noxious into harmless substances; and fourth, to secure the adoption of correc-

tive measures by National and State authorities; and

WHEREAS, the United States possesses 80,000,000 acres of swamp and overflowed land important for equalizing stream run-off by holding rainfall, and in many instances serving as the breeding grounds of fish and wild life; be it

RESOLVED: That indiscriminate drainage is to be deplored as a source of conspicuous waste, and that careful investigation should be made in advance of all drainage operations to determine resultant benefits and injuries.

X.—INTERNATIONAL RELATIONSHIPS

1. That the Federal authorities be requested to enter into negotiations with nations constituting the Pan-American Association and others adjacent to the United States, looking toward the formulation of conventions to protect migratory wild fowl and insectiverous birds whose habitat exists jointly in these countries and the United States; and
2. That we recognize the value of international athletic competitions as a means of promoting ideals of sportsmanship, mutual understanding, and respect among nations, and we appeal to all Government, Civic and voluntary agencies for encouragement and support of the representatives of our country in these international competitions; and
3. That the Consular Service be asked to effect exchange of information with foreign countries concerning governmental and municipal experience in developing physical training, playgrounds and outdoor recreation; and
4. That, in American institutions offering courses in recreation, special provisions be made for foreigners wanting to study American methods for use in their home countries.

XI.—FINANCIAL ENCOURAGEMENT OF OUTDOOR RECREATION

That the matter of financing the Outdoor Recreation Movement be referred to the Permanent Organization which it is hoped will succeed this Conference.

XII.—VALUE OF OUTDOOR RECREATION TO INDUSTRIAL WORKERS

1. That the President's Conference should emphasize the benefits which accrue from the provision of permanent outdoor recreation facilities within the reach of industrial workers and their families.

2. That the Conference should urge industries and mercantile establishments to provide, as opportunity offers, additional facilities for organized games; and to support municipal provision of wholesome, outdoor recreational facilities.

3. That the conference should call attention to the fact that activities of this kind require just as much thought, care, planning and supervision as any other phase of business, and that good intentions not founded upon knowledge, not guided by experience and training, have led to disappointment and failure in the past, as they have in operating departments.

4. That the Conference call attention to the value for agricultural workers of all types of informal recreation and organized games which develop team play, quickness and bodily skill, and to the value for city dwellers, especially those of mature years, of such recreations as fishing, hunting, boating and camping, which involve a complete change of environment.

XIII.—MUNICIPAL PARKS AND PLAYGROUNDS

That in view of the massing of our population in cities and towns, which, so far as foreseeable will increasingly continue: and in view of the helplessness of children and youths to determine their own environment, and admitting their inherent right to a place in which to play; the Conference recognizes that it is the duty of every community to provide and operate, either by public or private means, adequate space for play and recreation and that at least ten per cent of the area of a community should be regarded as the minimum requirement for this purpose, so distributed as to give all sections, as nearly as may be, equal accommodation both as to location and area.

And to this end in new city additions of ten acres or more this provision should be made a condition of such additions' acceptance by the municipalities.

And recognizing further that recreation, aside from its pleasure-giving object, is an important element in fostering good citizenship, it is the duty of the community to furnish on its playgrounds organized recreation under executive leadership of high character.

That the President's Conference on Outdoor Recreation looks with approval on those agencies and institutions seeking to give specialized professional training to workers in the various fields of recreation.

XIV.—EDUCATIONAL PROGRAM

1. That the Conference endorse Nature Study in Schools and the extension of the Nature Study idea to every American school and family

2. That provision be made in the curricula of all Normal Schools and Colleges for the training of the necessary teachers and leaders in Nature Study.

3. That the establishment of Museums of Natural History in National Parks will increase the educational and recreational value of the Parks.

XV.—OUTDOOR RECREATIONAL NEEDS OF CHILDREN

1. That the Conference believes that the basic recreational needs of all children are the same and urges the value of a statement of average outdoor standards for children, based on a thorough study. Such a statement will serve as a minimum which may be freely exceeded, but which we shall first endeavor to make universal.

2. That in view of the fact that 400 cities and towns of 8,000 or more are reported not to have a single playground or play leader, the Conference urges that these communities and all others take up the study of the outdoor recreation needs of their children, with the purpose of immediate action.

3. That the recreation needs of the country's 15,000,000 rural children should be studied and provided for in connection with the schools and in cooperation with agencies promoting helpful social activities as a means of enriching country life and counteracting the lure of the city.

4. That the Conference urges the basic importance of training leaders for recreational activities. It also calls attention to the need of recreation institutes with traveling instructors.

5. That the growth of our cities and communities has been such that inadequate provision has been made for the recreational needs of their people, and land within the corporation limits of such communities is costly. Very definite cooperation should be sought with cities, towns and rural communities looking towards the acquisition by gift, or purchase by public funds, of tracts of land generally unsuited for cultivation, but well adapted for outdoor recreation, within reasonable distance from the centers of said cities, towns or communities, with the object of developing such areas as may be selected for general recreational centers open to all citizens and their families under regulations to be determined by said cities and communities.

6. That commercial housing enterprises be urged to consider the setting aside of a certain proportion of land for the purpose of meeting the needs of the children for small interior playgrounds.

Practical Forest Management, By C. G. Trevor and E. A. Smythies. Government Press, United Provinces, Allahabad, 1923 Pp. XVIII & 220 & LXVIII. Plates 18.

The authors of this book hold the positions, respectively, of Conservator of Forests and Silviculturist in the Working Plans branch of the United Provinces of British India. As they state:

This book has been prepared with the object of placing on record in one place the details of forest management and working plan procedure as at present adopted in the United Provinces. It is written for trained forest officers and does not pretend to be a text-book for the student. Consequently it omits much matter which finds a place in text-books on silviculture and forest management, it presupposes in the reader a knowledge of forestry in all its branches and acquaintance with the ordinary professional terms of the science. It deals almost entirely with the practical management of the *sal, chir* and *deodar,* the three principal forest trees of Northern India, under the different silvicultural systems applied to these species, and describes in such detail as is necessary for working plans the technique of their treatment from infancy to maturity. Only the methods of calculating the yield which are actually used in practice have been described and examples from working plans have been given in every case. The book is published under the authority of the Chief Conservator of Forests, United Provinces, and is intended as a handy guide to executive and working plan officers in the ordinary course of their daily work.

The book does not pretend to be anything more than a useful compilation reviewing as a whole the forestry of the province, constituting a guide to the best methods of up-to-date management and laying down certain principles of technique to be followed by working plan officers.

The book takes up first the history and evolution of forest management in the United Provinces.

From 1869 began a small but steady stream of forest officers trained first in the French and German schools of Forestry (and later at Coopers Hill and Oxford), and with their arrival it was possible to make a start in scientific and systematic forest management by the preparation of the first working plans, and between 1875 and 1880 the preliminary work of demarcation and organization had advanced sufficiently in most divisions and working plans or preliminary felling schemes had been

prepared or were under preparation for the forests of Chakrata, Naini Tal, the Western submontane and Bhabar sal forests, Kheri and Gorakhpur.

Very considerable difficulties had to be overcome in the preparation of these early working plans, for it must be remembered that the forests were in a semi-ruined condition and far below their proper yielding capacity; the silviculture, rate of growth and other vital factors were only partially studied and the young department had to justify its existence by showing a budget surplus and had also to conserve and build up the timber supplies and bring the forests into a better condition. Working plans were required urgently over large areas, the available staff was limited, intensive working and extensive enumerations were not at that time feasible, and the executive and subordinate staff who had to carry out the markings of the coupes were untrained and often illiterate. Under these circumstances a special system of management was evolved which Recknagel calls the "Indian method," which was simple in execution, was guarantee against overfelling and for the improvement of the crop, and could be applied rapidly over extensive areas, and although the method has been often held up to criticism, it is difficult to see how any better or more scientific system could have been applied to suit the peculiar circumstances of the time.

This system of regulating the annual yield by volume based on diameter classes, and the time taken for trees to pass from one diameter class to the next, is fully described in Recknagel's "The Theory and Practice of Working Plans," and in all the old working plans of the province, and need not be described here. This system was adopted universally for all species and for all the forests in the United Provinces which were being managed under sanctioned working plans, and held sway for nearly 30 years, except in some sal forests with intensive demand, where the system of coppice with standards was adopted. Despite its shortcomings, it assured at least a wonderful improvement in the state of the forests, and paved the way for more scientific systems.

Previous to the creation of the Working Plans branch, i. e., for the first 40 years or more of scientific forest management, the preparation of working plans had been somewhat haphazard, at least as regards personnel, and it occasionally happened that an officer was put on to prepare a working plan without any particular aptitude for such work. Also in the earlier years, when the sanctioning of working plans was highly centralized, differences of opinion between the local officers and the higher authorities with the Government of India sometimes resulted

in unnecessary friction. The creation of the Working Plans branch, working directly under the Chief Conservator of Forests, to a great extent did away with the possibility of such anomalies and difficulties.

There follows a lengthy chapter descriptive of the forests of the United Provinces. Next the authors discuss the foundations of forest management. What they say about sustained yield is of particular interest to American readers and should serve to stiffen the backbone of foresters who are inclined to be satisfied with the fulfillment of certain vague "minimum silvicultural requirements."

"It is essential to the management of State forests that the forests should supply a steady annual income. It is the duty of the state to produce in perpetuity the largest possible quantity of the forest produce required for the daily wants of the population, as well as to guarantee an adequate supply of timber for large public works. It is therefore essential that each forest division be worked for a sustained annual yield to meet these demands, and that it should be our aim to produce the greatest possible amount of forest products with the smallest possible forest capital. The attainment of this maximum yield is only possible with complete stocking, careful tending of the growing stock and a proper series of age gradations. The neglect of the principle of the sustained annual yield has had the most disastrous consequences in America. Industries migrated and villages disappeared because there was no more merchantable timber to cut; *without a sustained yield the continuity of the forest and the industries depending on it cannot be insured.* In Pennsylvania and the Lake States the decay of agriculture, the migration of forest and wood using industries and the decline of previously prosperous villages have followed the destruction of the forests. *The whole science of forestry is dependent on this principle.* Neither silviculture, fire protection nor utilization are by themselves competent to maintain prosperity. *Once the principle of the sustained yield has been adopted everything else follows as a matter of course.*"

The chapter on the organization of the forest (note the term—*not* regulation!) under working plans, deals with Division of Area.

The division of a forest into compartments is the very foundation stone on which is built up the structure of the detailed management. This division into suitable compartments is the first duty of the working plan officer. The size of compartments will vary with the intensity of the management, all the latest plans have considerably reduced the size of the compartment and it is probable that finality has not even now been reached. A reasonable mean in the size of compartments must be

maintained; compartments should neither be too small nor too big. If too small, their numbers become excessive; if too big, they are impossible to describe. The old compartments of South Kheri extended over several thousand acres, their descriptions were therefore utterly useless. Compartments averaging 200 to 300 acres may under the present intensity of our management be considered satisfactory. This is about double the maximum in France.

The preliminary working plan report is prepared after consultation with the local executive staff, either by the Head of the working plans branch or under his orders. This report deals in considerable detail with the past system of management and its results, and that proposed for the future. Where any great changes are indicated in the management this report will deal with the division into working circles, the silvicultural system to be adopted, and the method of calculating the yield. It will set out in such detail as is necessary the framework of the revised plan, leaving the details to be filled in by the working plan officer. The preliminary report is forwarded to the Chief Conservator for his approval of the system of management outlined.

Light is thrown on the much-vexed term "working circle" in the chapter on the organization of the working plan. Here is the authors' definition:

"A working circle is an area subjected to one and the same silvicultural system and method treatment and which is exploited by a distinct series of operations. It may consist of one or more felling series. Having decided on the silvicultural system or systems to be adopted, it now becomes necessary to allot compartments to working circles in accordance with the way in which it has been decided to treat them. The broad outlines of the working plan have already been laid down, the working plan officer will consider the question of the allotment to working circles at the same time as he describes the compartments. In order that a working circle may be properly constituted it should contain crops of well graduated ages. As however under present circumstances the distribution of the age classes is never normal, the working plan officer must do the best he can with crops at his disposal and must make the best possible arrangements to obtain greater normality in the future. A working circle comprising as it does forests under one and the same method of treatment need not be in one piece; in fact it is seldom so. As a rule all the forests of a working circle must be managed on the same rotation and the yield calculated by the same or very similar methods. For instance forests in which the regulation of the yield is by area and by volume respectively should be kept in different working circles."

If now we compare this with the terminology adopted by the Society of American Foresters, the Indian "working circle" is seen to be synonymous with our "working group," i. e. "an aggregate of compartments or stands to be managed under the same silvicultural method and rotation." This is not the conception sponsored by the U. S. Forest Service which makes working circles a synonym of the working plant unit[1] and bases it on topography, ownership, transportation, objects of management, composition and condition of the forest and size and character of the investment for utilization!

The book then takes up in great detail the various silvicultural systems, including the management of bamboo forests. It ends with chapters on control of working plans, fire conservancy and resin tapping.

The appendix gives prescribed working plan headings and reprints silvicultural essays from "The Indian Forester."

So far as the reviewer (who has not had the good fortune to visit British India) may judge, the book deserves its title of "Practical Forest Management." It reflects the tremendous advance made in handling the great forest estates of the United Provinces and shows that the ideals of scientific forestry are coming to be more and more recognized. To Americans the book is of added value in supplying a parallel to our own struggles to perpetuate our forest heritage and an encouragement to further efforts in the preparation of working plans.

Ithaca, N. Y., A. B. RECKNAGEL
July 31, 1924

A Silvical Comparison of the Pacific Coast and Rocky Mountain Forms of Western Yellow Pine, By C. F. Korstian, Am. Journ. Bot. XI: 318-324, 1924.

Foresters are generally agreed that the western yellow pine occurring in the Rocky Mountains differs in many particulars from the typical *Pinus ponderosa* occurring in California, Oregon and Idaho. Some authorities regard the Rocky Mountain form (*scopulorum*) as a distinct species while others insist that it is only a climatic form of variety. Whether the differences are sufficient to warrant recognizing two species is of less concern to foresters than the fact that there are differences of silvicultural importance.

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[1]See "Division of the National Forests into Working Circles," Preston and Eldredge, Jour. For. XXI, 6, pp. 582-7.

Compare also Woolsey: "American Forest Regulation" where he defines Working Circle as "an economic forest area managed under one plan." (Page 20.)

Korstian has studied the two forms and finds consistent differences in general appearance, form, size and color of leaves and cones; differences in germination and development during the seedling stage; differences in chemical composition of oleoresin, seed and leaf oils; and differences in the anatomical structure of the leaves. From a silvicultural point of view the points worthy of recognition are that in general *scopulorum* germinates more quickly but develops more slowly during the first two or three years, and is much more resistent to drought and frost than is *ponderosa* when the two are grown side by side in the Rocky Mountains.

The author points out that although the two forms probably owe their existence to climatic adaptation, they possess definite inherent characteristics which are transmitted from one generation to another. In planting practice he advocates confining each form to its natural range, collecting the seed locally from sites similar to those to be reforested.

G. A. PEARSON.

Southern Woodland Trees, By James B. Berry. World Book Co., 1924. Price $1.20.

This should be a very useful handbook to teachers, students, lumbermen and others desiring to identify the more common and important forest trees of the Southeastern United States. Of the 211 pages, 14 are devoted to information on how to identify the wood of the principal and more common species of trees. The keys for helping to recognize the standing trees are based mostly on leaf differences, and a few on twig or fruit variations. Altogether 72 hardwoods and 10 conifers are described with text and drawings.

The nomenclature agrees in most cases with that of the leading tree botanists, and the drawings as a rule show the characteristic features. However, a few outstanding differences occur. For example, the variety *maxima* of the northern red oak (formerly Quercus rubra) is much more common in the south than the species *Quercus borealis*, as given in the book. Yellowwood is now known to occur across the Mississippi River in Arkansas. One may well question if the green ash should not have been included as it is quite common, and probably more so than the red ash which is included. In the drawings, the relatively large prickles of the loblolly pine cone scales are not brought out, and the common tridentate form of southern red oak (*Q. rubra*) formerly *Q. digitata* should have been shown. The beech leaf is more often three

inches in length than five as shown. Aside from these minor criticisms there are few inaccuracies.

The subject is treated in a systematic manner, and in a clear forceful style which should make the book very practical and useful. The large text figures will be of much assistance in tree identification to the average person who uses the book.

W. R. M.

"Growth in Trees and Massive Organs of Plants; Dendrographic Measurements; The Growth Record in Trees," by D. T. McDougal, and Forrest Shreve. Carnegie Institution of Washington, Publ. 350, 116 pp. May, 1924.

A recent publication by the Carnegie Institution of Washington gives further records of the daily course of tree growth obtained by MacDougal with his ingenious dendrograph, and very complete analyses of the entire stem of two Monterey pines and a redwood by Shreve.

Earlier work with the dendrograph, noted in this JOURNAL,[1] brought out the peculiar daily shrinkage and swelling of trees during the growing season. It appears that the changes which produce the shrinkage and swelling are not due to mere mechanical expansion and contraction of the woody portions of the trunk, but are attributable to processes associated with the life and growth of the tree. The action takes place only in the sapwood and living portions of the trunk. "Practically all organs or members tested with the dendrograph show daily equalizing variations in size or volume, which are referable to their water-balances. The condition of the stomatal slits, with implied effects on the transpiration rate, is seen to be the most important factor in these variations." Thus during the daytime, when the tree is giving off water through transpiration, there is shrinkage; at night, when the stomata are closed, there is swelling. With the giant cactus, *Carnegia gigantea,* the stomata close during the daytime, protecting the plant against excessive water loss, and open at night; swelling occurs in the daytime, and shrinkage at night, the reverse of trees.

The total increase registered by the dendrograph shows no constant relation to the total rainfall in Monterey pine, the tree most fully studied. Interference with the conducting and transpiratory system in Monterey pine was carried out, and the effect recorded on the dendro-

[1]B. M. Growth in Trees. Vol. XIX, No. 6, pp. 692-3, 1921.

graph. The results of girdling, defoliation and topping were about what would have been expected.

Shreve's complete analyses of tree stems show that the thickness of each annual layer of wood is different in the different parts of the stem. There seems to be no regularity in these differences which would permit relating stump measurements to the growth in other parts of the trunk.

The relation between annual rainfall, or growing season rainfall, and growth, was not as close as would be expected. In some cases there was a small positive correlation, in others a negative correlation. Correlation of growth with temperature, in two years having nearly equal rainfall, was also unsatisfactory. Shreve concludes that: "The collective results of this work confirm our knowledge of the dependence of growth on the entire constellation of environmental conditions, and indicate that the annual march of growth is not correlated with the march of individual conditions. Future investigations may make it possible to formulate a composite expression of the leading conditions, with which the march of growth would be in close correlation." Yet Douglass,[1] using long periods, has found a fairly close relation between precipitation and tree growth in western yellow pine, where moisture is the limiting factor.

B. M.

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[1]Douglass, A. E. "Evidence of Climatic Effects in the Annual Rings of Trees," Ecology, Vol. 1, No. 1, pp. 24-32, 1920.

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NOTES

THE EDITOR'S JEREMIAD

With this issue the JOURNAL takes on a new lease of life. It appears in a new garb—we hope a little more artistic—and is the product of an up-to-date printing shop. The gratifying fact is that this has been accomplished at a further reduction in the cost of printing.

The JOURNAL was one of the few scientific or technical magazines that, since the war, managed to keep its head above water in the face of more than doubled printing costs. This has been done, it is true, at some sacrifice in the appearance of the JOURNAL and the mechanical quality of the printer's art. Our first concern was to live and to get out our material at the lowest possible cost. We followed up all possible rumors of printing shops that could do the work cheaply, but almost every time we found that such printers proved mythical, and none could compare with the bids of our printer.

The present enterprise is somewhat in the nature of an experiment. The members complained of the rather shabby appearance of the JOURNAL. They wanted a respectable looking magazine, but were not willing to pay any higher price. They complained that the heartless Editor mercilessly cut out half-tones, condensed tables, and even frowned upon text figures. Although the appearance of the JOURNAL and its size may improve, the Editor does not promise any relief from the strictest economy when it comes to excessive tabulating material or illustrations which are not vitally essential to the understanding of the text.

The promise of a better paper, yet at a somewhat reduced cost, was made possible first by, we hope, the real interest of a big, midwestern publishing company in handling the JOURNAL, and second by sacrificing the high-grade services of C. M. Ballard, the only paid member of the JOURNAL staff. Ballard's services were invaluable to the Editor. He took off his shoulders the entire burden of the mechanical make-up of the JOURNAL and followed it through the press, and has done this loyally at a ridiculously small cost to the Society. The responsibility for the mechanical make-up will now be shared partly by the publishing company and partly will have to be assumed by the Editor. We hope under this new arrangement to secure a better looking JOURNAL, more space for original articles, more regular appearance of the JOURNAL on the first of each month, a promise of cheaper reprints, particularly for larger lots, and more rapid distribution of the JOURNAL throughout the country.

The Editor has been connected for 22 years from the very inception, first, with the Forestry Quarterly and, later, with the Proceedings of the Society of American Foresters, both of which finally merged into the JOURNAL. He is getting old and feels that he has served the Society long enough. He was not looking, therefore, for any additional burdens. In assuming this burden of preparing the manuscript for the printer, therefore, he hopes from now on to get more help from the members of the Editorial Board. He wishes to impress upon each member of the Board that a position on it is not merely honorary but actually carries with it the responsibility for the material within their respective fields. The Editor cannot engage in copious and frequent correspondence and does not feel that it is up to him to remind the members of the Editorial Board each month to send in material for the JOURNAL. He barely has time to acknowledge receipt of manuscripts and even in that he is often very, very remiss.

At times he dreams of the JOURNAL becoming not only the leading technical forestry magazine in this country but really winning for itself a place of distinction among the forestry periodicals of the world. But this dream cannot materialize through individual efforts. It must be the work of the entire Society. Some members of the Board take their duties seriously; others do not. We need a keen, critical attitude toward the JOURNAL from all members, not merely abuse, but real, constructive comment and, particularly, willingness to lend a helping hand. The JOURNAL may become either a great factor in the promotion of forestry in this country or may degenerate into an anaemic, professional organ with practically no influence, depending upon the determination, pride, and professional interest the Society is capable of developing.

What will it be?

EDITOR

Eugene Warming (1841-1924)

Foresters and all folk interested in ecology (and who of us should not be concerned with fundamentals?) will regret the passing on April 21st last of the illustrious Dr. Eugene Warming, emeritus professor of botany at the University of Copenhagen, at the age of 83. He occupied the chair of botany at the University of Stockholm from 1882 to 1885, and from 1885 to 1911 (when he retired from active service) at the University of the Danish capital.

Probably the Styrian professor, Reiter (in 1885) was the first to use the term *ecology* ("oekologie"), while Haeckel the following year apparently first defined the term. But it was the Danish teacher, Warming, who by his lectures in the early '90's first aroused interest in this new science, and to him rightly belongs the honor of being called "The Father of Ecology." Warming's "Plantesamfund" of 1895, followed in 1909 by Groom & Balfour's English edition of Warming & Vahl's "Oecology of Plants," may virtually be regarded as zero-milestones in the pathway of American ecology. Incidentally, here is hope for the slow-struggling but persistent—here is a man who did not attract attention until over 50 years of age, and who was nearing three-score and ten when he reached the ears of most of his English-speaking hearers.

W. A. Dayton

WOOD-PRESERVATION RESEARCH

Director E. R. Weidlein of Mellon Institute of Industrial Research of the University of Pittsburgh has announced the founding of an Industrial Fellowship on the treatment of timber. This research, which is being sustained by the Grasselli Chemical Company, of Cleveland, Ohio, and is being conducted by Dr. A. M. Howald, has for its purpose a study toward improvement of the methods of applying zinc chloride in the wood-preservation industry.

Investigational work which was begun during 1923 will be continued throughout the present year. An experimental wood-impregnating plant is maintained for practical tests of processes. Research is at present being done under the supervision of Dr. Howald on the development of a method of increasing the permanence of zinc chloride treatments of timber by the addition of petroleum oils.

SOCIETY AFFAIRS

NEW ENGLAND SECTION SUMMER FIELD MEETING

The New England and New York Sections held a joint summer meeting at Athol, Mass., on June 26 and 27.

The reason for the location of the meeting in this town was that it is the nearest railroad station to the Harvard Forest in Petersham where under the direction of Professor Fisher one day was spent in looking over the many sample cuttings and the results obtained in getting a natural reproduction of the white pine and more valuable hardwoods.

The careful system of management of the 2000 acre forest on the sustained yield basis was also a most interesting demonstration and the 75 members and guests present voted it a day full of the greatest educational value.

Each Section and the two jointly held business sessions. The New England Section nominated 19 men for membership, 16 as members, 2 as Senior members and one associate. The two sections acting together, nominated Prof. R. T. Fisher of Harvard as a Fellow.

There was a considerable discussion of the plan to employ a paid secretary for the Society. The majority favored it, although considerable opposition developed.

The second day was given over to a trip to Winchendon, where the plant and some of the forest holdings of the E. Murdock Company were inspected. This concern which has been in operation for 75 years, has been practicing rule of thumb forestry on its holdings of 20,000 acres for the past 30 years, and has now gone into more scientific forestry work under the direction of a graduate forester. Its progress is being watched with great interest by all New England Foresters.

The meeting closed with luncheon on the Otter River State Forest in Winchendon.

SOCIETY OF AMERICAN FORESTERS SOUTHERN APPALACHIAN SECTION

The third annual meeting of the Souther Appalachian Section of the Society of American Foresters will be held in the Y. M. C. A., Asheville, North Carolina, on February 2nd, 1924.

The business session will open at 10 A. M. During this session the Forest Type Classification Committee report will be presented for discussion.

During the afternoon session, beginning at 2 P. M., the following papers will be read:

1. "Chestnut Wood in the Tanning Industry," by Robert W. Griffith, Sales Manager, Extract Department, Champion Fibre Company, Canton, N. C.
2. "Progress of the Chestnut Blight in the Southern Appalachian Forests," by G. F. Gravatt, Pathologist, U. S. Bureau of Plant Industry, Washington, D. C.
3. "The Position of Chestnut in the Timber Sale Policy of the Pisgah National Forest," by M. A. Mattoon, Forest Examiner, U. S. Forest Service, Asheville, N. C.
4. "Some Silvicultural Aspects of the Chestnut Blight Situation," by E. H. Frothingham, Director, Appalachian Forest Experiment Station, Asheville, N. C.

All forest fire wardens, forest rangers, timberland owners and others interested in forestry in this region are most cordially invited to attend this meeting and to participate in the discussions.

C. F. Korstian, *Secretary.*

SUMMER MEETING OF ALLEGHENY SECTION

The summer meeting of the Allegheny Section of the Society of American Foresters was held on the eastern shore of Maryland on July 25 and 26, 1924. State Forester F. W. Besley and Assistant Foresters Karl E. Pfeiffer, J. A. Cope, and F. B. Trenk acted as official guides. The visiting foresters report that they enjoyed one of the most interesting summer meetings in the history of the Allegheny Section. Fifty-one foresters, the largest number in the history of the Section, were in attendance. Each member of the party was supplied with a 10-page program and a map showing the route of the field trip.

Many interesting forest conditions and forest projects were inspected during the two days. Loblolly plantations established with nursery grown and wild stock were seen, and different kinds of thinnings were also shown. Splendid examples of natural seeding in old fields were seen showing successful restocking as far as 500 feet from the seed tree. It was also demonstrated that controlled burning may insure successful regeneration. Abundant regeneration of loblolly pine was shown on a number of tracts that were burned over just prior to heavy seed years. The Maryland foresters are of the opinion that controlled burning gives satisfactory results in that the removal of shade and

exposure of mineral soil are essential for restocking of pine lands. In many places the plan adopted is to remove the hardwoods and give preference to the pine. It is generally recommended that the hardwoods be allowed to grow until sufficiently large to cover the cost of removal as well as subsequent planting. It was suggested that the hardwoods be removed in many places when about 15 years old, and in all cases vigorous 2-year planting stock should be used in planting work.

Individual staked trees located on sample plots showed that loblolly pine makes remarkable growth when young. A two-year old tree growing under a sassafras was 18 inches high, while another two-year old tree growing under a scarlet oak was 22 inches high. This rapid rate of growth continues, for a stand of 33-year old loblolly pine when thinned in 1923 contained 23,350 board feet. The 98 trees that were removed by a grade "C" thinning yielded 3,350 board feet.

The field trip not only showed forest conditions but also familiarized the visiting foresters with the great vegetable and fruit industry which has been developed on the eastern shore of Maryland. It has been claimed that Maryland grows more tomatoes than other state in the Union. This implies the use of a large amount of wood to provide containers. It is estimated that the annual consumption of native grown loblolly pine for vegetable containers is approximately 2,000,000 feet in the Salisbury district alone. In order to supply the vegetable industry with containers for the vegetable products, a considerable number of small wood-using industries have been developed. A plant which specializes in the manufacture of 14, 16, and 32 quart hampers was visited. In the manufacture of these hampers, veneer panels of white and black gum from North Carolina and local sycamore and poplar are used. The bottoms of the baskets are made from loblolly pine. A local stave mill was also inspected, which is an essential accompaniment to the potato industry on the eastern shore. Another plant on the trip was engaged in the manufacture of strawberry and cantaloupe crates, box shooks, and containers.

A number of big and rare trees also featured the trip. The Seaside Alder (Alnus maritima) is so in love with the eastern shore that it grows nowhere else in the world. This tree blooms in the fall of the year, just to be distinctive from its close kin. On the property of Mr. Lankford at Beckford Manor, Princess Anne, grows a giant Pecan Tree. It is 124 years old, 110 feet high, has a circumference at breast-high of 14.2 feet, and at 2 feet from the ground it is 18.7 feet in circumference. It has a branch spread of 132 feet and is reported to have

yielded as many as 15 barrels (45 bushels) of nuts. Near it stands a black walnut tree that may appropriately be called a tree giant. Near the town of Berlin stands what is reported to be the largest English elm tree on this side of the Atlantic. It is 80 feet high with a branch spread of 116 feet, and just below its first large limb it is 23.6 feet in circumference.

Not a small feature of the trip was the privilege of seeing the famous Pocomoke Swamp, which is the first cousin of the Great Dismal Swamp of Virginia. In it occur virgin cypress, overcup oak, and swamp cottonwood.

The third annual summer meeting of the Allegheny Section was the best attended field meeting in the history of the Section. The foresters of the Pennsylvania Railroad were out in full force, there being eight in the party, which gives them an 100% attendance.

On the trip were 17 foresters from Pennsylvania, 13 from Washington, D. C., 11 from Maryland, 5 from New Jersey, 4 from Virginia, and 1 from Connecticut, all of whom report that this summer meeting stands out among the most interesting and instructive that the members of the Allegheny Section have had the privilege to enjoy.

JOSEPH S. ILLICK, *Secretary.*

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